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AN ECONOMIC INVESTIGATION OF THE MONTANE TUSSOCK-GRASSLAND OF NEW ZEALAND.

XII. THE REGRASSING EXPERIMENTS IN CENTRAL OTAGO.

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PART II.—OBJECTS, PRINCIPLES, AND METHODS.

THE preliminary examination of the pastures of Central Otago, made by me in the late summer and early autumn of 1919, showed that, apart from such ground as could be irrigated, no really sound knowledge regarding their improvement could be gained except by experimental methods. It is true that, in the valleys, enclosures which had been fenced from stock and rabbits for some years exhibited, according to the length of time during which they had been enclosed and without water other than rain, every stage of regeneration from the original almost bare ground to a close covering of vegetation—an important matter already dealt with in this series of articles.* But this regeneration occurred only in the valleys or low down on the bases of the hills, so no information was available regarding the upper and greater part of the depleted area—that is, the all-important winter country of the sheep-runs, where the conditions for regeneration, as shown in Part I of this article, are different from those of the valleys, and are themselves far

* See this *Journal*, Vol. xx, Feb., 1920, pp. 82–94.

from uniform. Nor are precise particulars available concerning the actual plant contents of these areas in the valleys at the time of their enclosure, and their subsequent histories. For instance, a most important and fundamental point is whether the new vegetation has arisen, in the first instance, from seed, or from plants which were already in the ground when it was enclosed, though hardly visible through their close cropping by rabbits. In other words, would spelling, as so many believe, alone suffice to bring about regeneration? In the summary to the article just cited the opinion is expressed that "Most likely a good deal of regeneration arises from seeds being blown on to the enclosed area, though in many cases it arises from plants already on the ground" (*loc. cit.*, p. 94).

But even if spelling would suffice it did not seem to me, in view of the capabilities of the rich mica-schist soil, that a mere return to the original pasture of low feeding-value ought to be the destiny of the depleted lands. Rather, if regrassing were feasible, would it not be possible to clothe the now barren slopes with plants of high rather than of low pasture-value? Even if none of the pasture-plants at present in New Zealand were suitable, there would be the pastures of the whole world available for material. These facts, and others detailed under the next head, clearly show that experiment was most desirable.

This view I laid before the Director-General of Agriculture in a report. After due consideration he arranged that experiments on the lines therein indicated should be carried out. These have been in progress since the end of January, 1920, so far as spelling is concerned, but with regard to sowing, &c., only since the middle of May, 1920—that is, for about two years and two months. Here, and in Part III of this article, the results of the experiments up to 16th May, 1922, are dealt with.

About twelve years ago the Department of Agriculture commenced a series of experiments on the Mackenzie Plain and near Clyde, but of a kind fundamentally different from those described below. A fair amount of surface-sowing on depleted ground exposed to stock and rabbits was also carried out. This sowing showed that usually no grass was established; nevertheless in specially favoured spots, as I have noted, more or less grass, evidently due to this sowing, is still to be seen. The Clyde experiments, which alone concern this article, have clearly demonstrated that many grasses, clovers, and other plants can be successfully established, and will increase, if sown in a well-prepared seed-bed on ploughed or cultivated ground and kept free from stock and rabbits.* Of course, this was already known from ordinary farm practice in the district; but the important part of the work near Clyde was the establishing of many species possessing pasture-value which had not hitherto been grown in Central Otago, as also was the successful growing of lucerne and cocksfoot for ten years or more under conditions apparently of extreme aridity. The area has since proved of great value in grazing experiments and subsequent spelling,† and in demon-

* For an account of the Earnscleugh experimental area, Clyde, its condition in February, 1920, and a list of its plants, see No. VIII of this series in this *Journal*, Vol. xxi, Oct., 1920, pp. 178, 180, and 187–88.

† See No. IX of this series in this *Journal*, Vol. xxi, Dec., 1920, pp. 324–34; and No. X, *ibid.*, Vol. xxii, Mar., 1921, pp. 148–57. In the last-named article there are certain details regarding the climate of depleted Central Otago, pp. 149 and 151.

strating the establishment under arid conditions of plants from seed buried by the trampling of sheep (see Fig. 1).

In 1912 Mr. D. Petrie, M.A., F.N.Z.Inst., in a report to the Department of Agriculture,* had intimated that the regrassing problem demanded experiment. He suggested that an area of land be fenced in above the race feeding the Cromwell dam.† "Such a station," he writes, "seeded from the plants growing on the edge of the race, would soon show whether sun-scorching and wind-desiccation or the eating-out of the seedling grasses is the dominant factor in preventing the native grasses from reclaiming the desert lands on which they formerly flourished. I know of no locality where this important question can be tested more conveniently or in a more conclusive way." Farther on, the same writer expresses his conviction that spelling alone will do no good; nevertheless he considered that "The question is of sufficient importance to justify the enclosure of a typical and fairly large patch of the desert hillside, to ascertain what spontaneous improvement a few years' rest could effect." He considered the Earnscleugh area of 20 acres as altogether too small, and not varied enough in its stations for plants, to give reliable results.

It will be seen from what follows that Petrie's suggested experimental methods and mine are essentially different, except in the matter of natural sowing from growing plants; but even in that regard Petrie relies on seed coming from plants outside the enclosure, while I choose areas which already contain living plants suitable for producing and scattering seed.

OBJECTS OF THE EXPERIMENTS.

The general object of the regrassing experiments is either to find out methods which may be used for regrassing the depleted area, or to gain evidence that regrassing at anything like a reasonable cost is impossible. In order to procure such information precise knowledge on certain matters must be ascertained. The following appear the most important:—

1. To find out the effect of spelling alone, and the length of time which must elapse before results of moment come about. Here comes in the spelling of a large area with various soil conditions and aspects, and the spelling of uniform areas of different kinds. It is also important to find the effect of keeping out sheep alone and rabbits alone—a matter which Mr. Middleton considers of fundamental importance.

2. To ascertain the results brought about by sowing the seeds of various kinds of pasture-plants, apparently suitable for regrassing operations, both in the presence and absence of stock and rabbits. Here misleading information may easily arise owing to the number of stock or rabbits being a highly variable quantity.

3. To study the effects of different soil or climatic conditions with regard to the germination of seeds, the establishment of plants, and their subsequent rate of growth.

* "Report on the Grass-denuded Lands of Central Otago," Bull. No. 23 (n.s.), N.Z. Dept. Agri., 1912, p. 13.

† For photograph of the race and area adjacent, see No. III of this series in this *Journal*, Vol. xix, Sept., 1919, p. 134.

4. To learn at what season seeds of the various pasture-plants can be sown with the best results. Here one is confronted with a climate varying more or less year by year.

5. To ascertain the results of different methods of sowing the seeds.

6. To learn definitely whether certain species desirable for introduction will or will not grow.

7. To gain information concerning the rate of growth and the amount of fodder produced by the various pasture-plants when growing under arid conditions.*

8. To discover what intensity of grazing the various species will tolerate when fully established.

9. To ascertain the results of seeding from plants *in situ*.

10. To find out if trees can be established either by planting or sowing.

THE PRINCIPLES UPON WHICH THE EXPERIMENTS ARE BASED.

The principle which lies at the root of the experiments is that of applying the exact knowledge gained from a close study of the history, flora, and vegetation of the depleted areas (the results of which have been briefly stated in Part I of this article)—that is, the methods of nature are to be followed as far as is feasible.† For instance, it has been seen that nature has sown seeds broadcast upon the bare inhospitable ground; and from such plants as appeared the rigid selective power of the environment has allowed only those to survive which are so constructed as to be able to withstand not only excessive drought, but also grazing of the hardest character. It has also been seen that some of the plants thus established are more or less palatable, and that some of the most palatable of the primitive grassland species still linger here and there, though so small and closely eaten as to generally escape notice.

As the vegetation established by nature varies according to aspect, altitude, and the quality, physical condition, water content, and depth of the soil, such vegetation of any area is a reliable index of its capabilities for regrassing; and the dominant species of this vegetation may be looked upon as indicators of what will or will not grow. For instance, the occurrence of scabweed in profusion is a certain indicator of the almost maximum adverse conditions for regrassing (see Fig. 2)—the absolute maximum being denoted by either completely bare, much wind-eroded ground, or land on which the scabweed is being rapidly eradicated. On the other hand, fiorin (*Agrostis alba*) speaks equally plainly of a soil constantly moist.

In the depleted country, as seen in Part I, nature has no large number of species tolerant of arid conditions on which she can draw; also, she is hampered by the extreme slowness with which many such species extend their range. Experiment, on the contrary, can proceed far more rapidly and has a considerable amount of material available.

* I am carrying out a series of experiments with many indigenous grasses, one object of which is to ascertain their rate of growth and seasonal or monthly yield when cultivated in the lowlands in the neighbourhood of Wellington. This, although the conditions are far from being arid, should give important information for purposes of comparison.

† For a general account of studies of this kind see L. Cockayne, The Importance of Plant Ecology with regard to Agriculture, *N.Z. Jour. Sci. & Tech.*, March, 1918, pp. 70–74.

FIG. 1. SEEDLINGS OF LUCERNE ON THE EARNSCLEUGH EXPERIMENTAL AREA.

These seedlings resulted from seed trodden into the ground by the sheep grazed on the area in the early autumn of 1920.

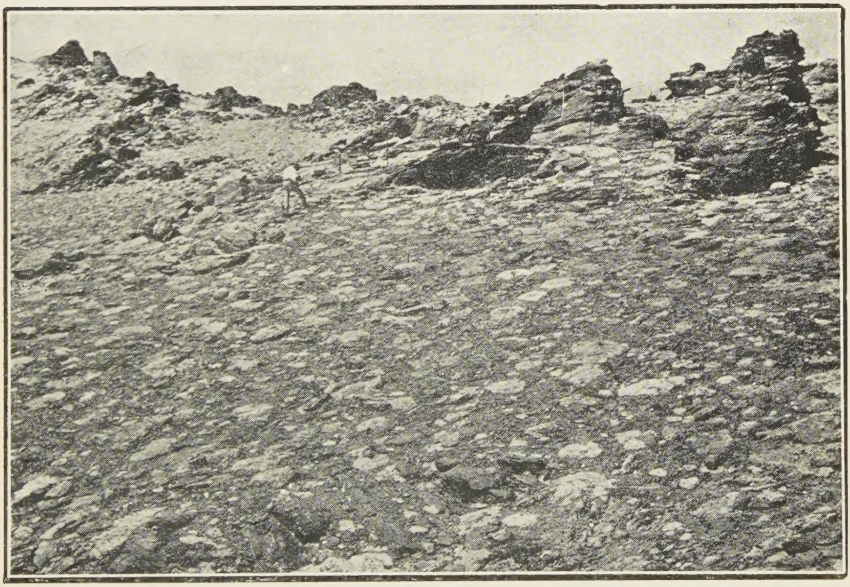

FIG. 2. VIEW OF PORTION OF PLOT NO. 4.

This photo was taken soon after the enclosing of the plot, and shows the extremely depleted ground with abundance of scabweeds and little else.

Photos by W. D. Reid.

Here again field observations come in, and the greater the knowledge of plants in their natural habitats possessed by the experimenter, the more easy it is for him to avoid that loss of time brought about by using empirical methods, for many of those most likely to thrive are known already and can at once be made use of.

But empirical methods, quite different though they are from those under discussion, are not to be despised, since plants apparently most unlikely to succeed according to nature's teaching may be of considerable value. Thus it will be seen in Part III that tall fescue (*Festuca elatior*)—a swamp grass—promises to be specially suitable for arid areas.

It seems quite sound to assume, with regard to the experimental plots, that what will take place on a small area—say, a quarter of an acre in extent—in the matter of seed-germination, growth of plants, and spelling, will happen on a much larger area so long as the conditions for vegetation are exactly the same on both areas. If this be so there is no need for large experimental plots. In point of fact, exact similarities of environment in two or more such areas do not exist in nature, but the actual differences may be so slight over much of each area that it is justifiable to consider the conditions identical. Small plots have also the great advantage that those changes in the vegetation which take place from time to time, due to the conditions imposed by the experiment, can be far more easily and accurately estimated than would be the case in the larger ones.

As there are various types of habitat on the depleted slopes of the mountains, there can be no uniformity in the behaviour of the plants introduced thereon. Any experiments, then, designed to furnish a true idea either of spelling a large area extending from the base of the mountain to the grass-line, or of the possibility of growing plants over the whole area, must be sufficient in number to allow at least one plot for each type of habitat. But between the typical habitats there exist many others of an intermediate or transitional character. Some of these are certain to be represented in almost any area of a quarter of an acre, while plots can also be selected on account of their lack of uniformity, and thus various lessons could be learned on the one plot (see Fig. 3).

Spelling, that highly important object of the experiments, demands a careful survey of the vegetation of each plot in the first instance so as to learn exactly what each contains, and periodical surveys to note what is taking place. Then, if regeneration is in progress, its rate of progression is the point of special moment, for it may easily be too slow to be a paying proposition. With spelling may go, hand-in-hand, seed-sowing, so that each plot can serve at any rate a dual purpose.

No method of treating the experiment plots can be applied which is likely, when used on a large scale, to cost more than will be profitable. Thus ploughing, even if possible, is out of the question. On the other hand, there is much country where, if it is proved that sufficiently good pasture can be established by that method, a light harrowing might well be a payable proposition.

As it has been shown clearly by the Earnscleugh area and by many observations that various palatable grasses, clovers, and other herbs grow well on badly depleted land, even where there is the minimum rainfall, an important principle is the using of species of higher pasture-

value than those of the original grassland. It should be only after failure to establish these better plants that a restoration of the primitive plant-covering be aimed at. The latter object has, up to the present, been the ideal of those who have so frequently suggested spelling as the panacea. In the arid depleted areas of the United States, too, the restoration of the original grassland appears to be the chief aim.*

THE METHODS OF THE EXPERIMENTS.

In the report submitted to the Director-General it was suggested that twelve rabbit-proof enclosures, each about a quarter of an acre in area, be erected in some part of the worst-depleted area, these enclosures to represent the typical habitats of such country from an altitude of nearly 1,000 ft. to the border-line between the depleted and the grassed areas at about 3,000 ft. altitude. According to the principle already mentioned, such small areas if well chosen should give an accurate account of what would eventually happen were the entire area on which they were situated to be spelled. Also, they could be used for experiments in sowing and for various other purposes.

Mr. J. L. Bruce, of the Department of Agriculture, who had had many years' experience of Central Otago, was deputed to accompany me, and together we were to choose the sites for the plots and arrange for the fencing to be carried out. After going into the matter in its various bearings we decided to explain our views and seek advice from certain of the local runholders, whose practical knowledge would be of great advantage in the work. Accordingly, we consulted Messrs. R. K. Smith, of Tarras, and D. Middleton, of Northburn, who willingly consented to act with us as a committee. Finally, it was decided to carry out the experiments on Mr. Middleton's Northburn Run, since it was easy of access and typical of much of the depleted area. Mr. Middleton also kindly consented to supervise the fencing, and to arrange that the plots should be visited at comparatively short intervals in order to keep them free from rabbits.

The following day Mr. Middleton, Mr. Bruce, and myself visited Northburn Run and selected the sites for nearly all the plots. These varied from the most stony, exposed, and highly depleted ground (see Fig. 2) to deep soil on dark faces where Californian thistle (*Cnicus arvensis*) is frequently abundant (see Fig. 4). In one case two slopes of different aspect, and facing each other, were selected, while another of a saddle shape gave two distinct aspects and classes of soil (see Fig. 3). In some were rocks among which grew certain indigenous grasses, especially tall blue-tussock (*Poa intermedia*) and blue-grass (*Agropyron scabrum*), whose seeds at times would reach the bare ground in their vicinity. The final plot, situated at nearly 3,000 ft. altitude, was later on selected by Mr. Middleton himself in order to show the effect of spelling country near the upper limit of depletion, where there is more or less nearly dead tussock.

The fencing of the plots was no easy matter, as some are in positions difficult of access for fencing-material, and frequently the ground was extremely hard and rocky. By the end of January, 1920, the fencing was completed; and in February, with my assistant, Mr. W. D. Reid,

* A. W. Sampson, Plant Succession in Relation to Range Management, U.S. Dept. Agri. Bull. No. 791, p. 74, 1919; also, F. E. Clements, Plant Indicators, pp. 310–15, Washington, 1920.

I spent several days in dividing the plots into sections and in taking detailed notes of the plant contents of each, or, if the plot was almost bare, with little but the scabweed mats, the notes were more general.

In order to divide the plots into their sections certain of the standards were labelled. In every case the north-west corner post was marked A with lead-pencil on a patch of wet white paint, and then, at regular intervals, standards were marked B, C, D, &c. The parallel fence was similarly labelled, and so, too, were the two other parallel fences, but in their case the lettering was a, b, c, &c. Then pegs were put into the ground to mark the lines AA, BB, &c., and the cross-lines aa, bb, &c., so that each plot was eventually divided into sections named Aa, Ab, Ac, and so on. Notes of the labelling of each plot were taken, so that if the letters on the standards became illegible it would be easy to find the exact limits of the sections. Notes were taken of the plants growing in each section. Later, in the spring—October, 1920—when many of the plants were easier to recognize, the results of the first survey were checked and additional plants recorded, so that there is an accurate enough account available of the original plants of each plot. Their increase from seed and rate of growth can be readily estimated, and no fresh species can come in from outside without being detected. To each plot a number was given, commencing with the lowest, to be known as plot 1, and ending with the uppermost, plot 12. The altitudes have been noted by aneroid on various occasions, so are correct enough for all purposes, for a few feet either way make no difference.

In accordance with the principles already explained, the treatment so far extended to the plots has been as follows: Each was divided into three parts, two of which were for autumn and spring sowing respectively, and the third for the planting of certain grasses, clovers, and other herbs, in order to see, firstly, if such would grow if planted with care, and, secondly, to establish plants in order to find out if the seeds from such would germinate under the conditions supplied by the environment, the seedlings being readily observed on the bare ground. Evidently, if there were no such germination, it would be useless to use those particular species for regrassing, since this must depend upon the establishment of a few plants in the first instance, which would populate the ground by means of seed, rather than upon the sowing of the very large quantity of seed required to make a close covering. Further, the planted species should seed much earlier than the same species raised from seed, and so time be saved.

The main sowings and planting were carried out solely by Mr. Reid, since not only had he the necessary experience in such work, but because the employment of one person could alone secure uniformity in the different sowings. In order to save time and to economize space the seeds of the different species used were mixed together. Such a mixture was not in the least designed to test its value as a mixture for regrassing purposes, but only to ascertain the power and rate of establishment of its various constituents. The composition of the mixtures will be best dealt with in Part III of this article, when discussing the results of the experiments.

As only the cheapest methods were allowable two alone were followed—namely, *broadcast* and *raked*. The latter was designed to

FIG. 3. VIEW OF THE SADDLE-SHAPED PLOT 10, TAKEN SOON AFTER IT WAS ENCLOSED.

Showing the sunny exposed face on the left with many scabweeds, and the dark face on the right, where the soil is deeper and not nearly so hard.

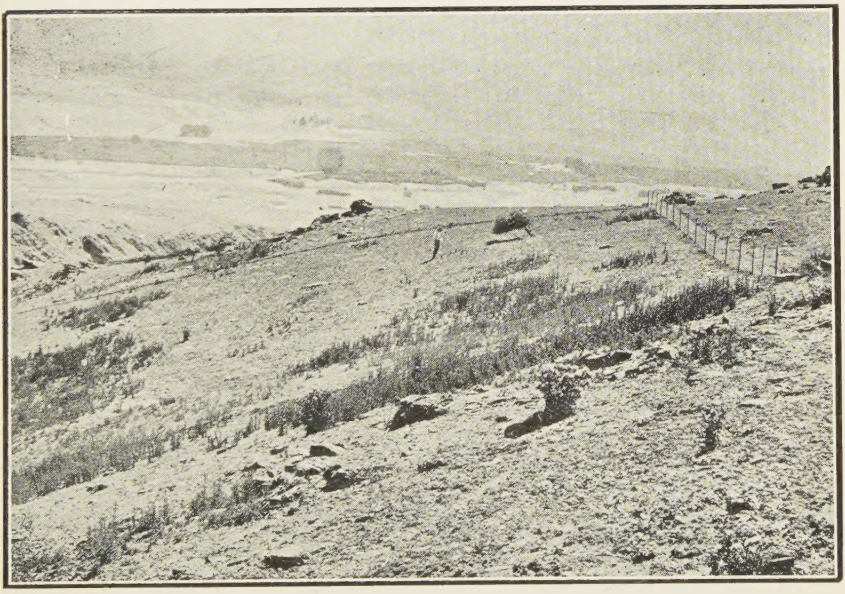

FIG. 4. VIEW OF PLOT 6 SOON AFTER ITS ENCLOSURE, SHOWING PATCHES OF CALIFORNIAN THISTLE.

This plot is on a fairly dark face, and the soil is of the best quality.

[*Photos by W. D. Reid.*

prove if harrowing—a far more efficacious method—could be used, since there are many thousands of acres where harrowing with one stroke, or probably with two strokes, should not be too expensive. In the raked method the seed was first scattered broadcast, and then the ground was lightly raked once with an ordinary garden rake. In many places the surface was so hard that the rake made virtually no impression. The raked method was fully approved by Messrs. Smith and Middleton.

The planting was carried out with plants specially prepared for the purpose by Mr. J. Beverley, at the Weraroa State Farm, and with trees supplied from the nursery of the State Forest Service at Tapanui. A list of these will be given in Part III of this article. As the object of growing these grasses and trees was to get them well established as rapidly as possible for the purposes already indicated, and not to show how such should be cheaply planted for regrassing or forestry purposes, at the time of planting water was put into the holes where they were to be placed. Bringing this water on to the ground was no easy task, for not only had it usually to be brought from a considerable distance, but also from a deep gully far below. Nor was it always easy to make holes in the hard stony ground. Horses for carrying the seed, plants, water, and various implements were generously supplied by Mr. Middleton; indeed, throughout this experimental work his willing assistance has been invaluable, and I take this opportunity of most sincerely thanking him.

THE SOWINGS.

The first sowing took place in the middle of May, 1920, at which time the planting of pasture-plants and trees was also carried out. The second sowing was made at the beginning of the September following, and the third early in March, 1921. Thus there have been two autumn (early and late) and one spring (early) sowing. The March, 1921, sowing was made on a portion of the ground of the May, 1920, sowing where the germination had been the poorest. Mr. Reid has supplied an excellent series of maps drawn to scale, showing the exact position of each sowing and of the plants of the planting. In the March sowing I sowed carefully in nearly all the plots, in short rows, each species by itself, covering the seeds with soil, in order to ascertain its germinating-power under the arid conditions and to learn if after germination plants would be properly established. Evidently those which fail to become established after such treatment, unless they have been too thicky sown, will almost certainly be useless for either the broadcast or raked methods. Also, near the fence in plots 1, 2, and 13, I sowed some insignis pine, dropping two or three seeds into shallow holes made with a short pick and then covering them with soil. As well as the sowings made inside the enclosures, small areas on the depleted ground outside were sown by the broadcast and raked methods. These also are shown on the plans.

In addition to the twelve plots three sowings, exactly similar to those described for the plots, were carried out within the experimental area planted with trees and fenced from rabbits, on the Sugarloaf, near Lowburn Ferry, on the 20th May, 1920, 10th September, 1920, and

6th March, 1921; also sowings were made outside on the first two dates. Here a good deal of regeneration had taken place since the fencing, especially of blue-grass and of tall blue-tussock, so it might well be expected that other drought-resisting plants would be established from seed.

Then in the Earnscleugh experimental area, already fully described in this series of articles,* a sowing of $\frac{1}{20}$ acre in extent was made in May, 1920, on the half-acre of depleted ground which had been fenced from rabbits a short time before (see *loc. cit.*, p. 179, Fig. 2), and another sowing was made outside; the same mixture and methods were used as those for the Northburn plots.

The trampling of the numerous sheep used in the first palatability experiment on the Earnscleugh area had amply proved that greatly increased germination of lucerne (see Fig. 1), cocksfoot, and other plants was so induced. This fact I brought before the Director-General, and he readily agreed that an enclosure should be made on the lower country of the Northburn Run to test the sheep-trampling method. By taking advantage of an existing fence it was possible, for the sum allowed, to fence in a piece of ground $1\frac{1}{2}$ acres in extent and to subdivide it into three half-acre plots, to be known respectively as 13A, 13B, and 13C, the first-named being the most westerly. Early in September, 1920, these plots were treated as follows: Seed was sown broadcast on plot 13C, and then the ground harrowed with one stroke of the harrow. Plot 13B had 128 sheep driven twice round over the broadcast seed. The same sheep were kept on plot 13A for forty-four hours, seed having previously been scattered over the ground and hay placed there for food. On the 5th March, 1921, part of plot 13C was harrowed with one stroke, then seed was sown broadcast and the ground again harrowed similarly.

In addition to the experiments already detailed some sowings have been made in the open on a larger scale, using the harrow method. Near plot 13, on the 23rd September, 1920, about $1\frac{1}{2}$ acres was sown broadcast and then given one stroke of the harrow. A portion of this area was again sown on the 5th March, 1921, but this time it was harrowed both before and after sowing. On the 11th December, 1920, another area, adjacent to the last, but on much steeper ground, was harrowed, sown broadcast, and again harrowed. This, obviously, was an exceptionally severe test, the sowing being made at perhaps the most unfavourable period of the year. On the 11th March, 1921, an area of 1 acre on the depleted ground above the Earnscleugh experimental area was harrowed, sown broadcast, and again harrowed. In the experimental area itself a similar sowing of half an acre was made.

CONCLUSION.

In the final part of this article details will be given regarding the species used in the experiments, the amount of seed and rate per acre sown of each species, the climate month by month for the period of the experiments up to the 11th May, 1922, the results of the experiments up to that date, and some of the lessons which they appear, so far, to teach.

* See this *Journal*, Vol. xxi, Oct., 1920, pp. 176–82.

SUPPLEMENTARY FORAGES FOR DAIRY COWS.

A SUGGESTED CROPPING SYSTEM.

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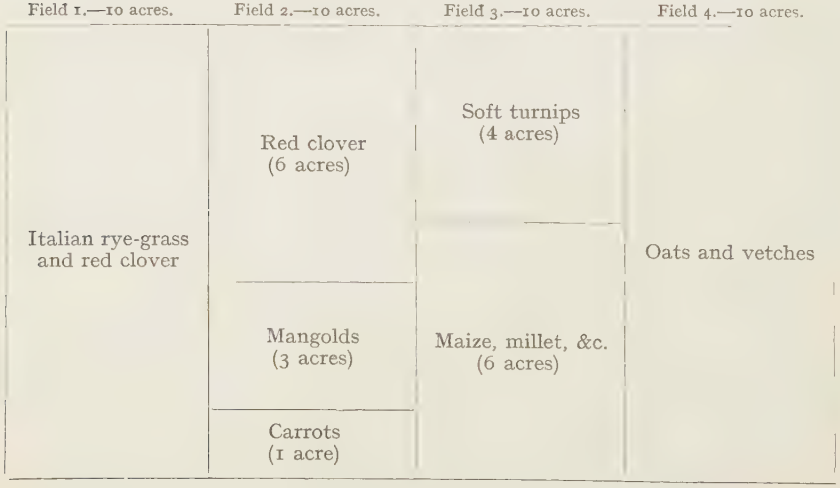
[The substance of this article was given as a lecture at the recent Farmers' School at Ruakura, and was addressed primarily to Auckland District dairymen. With certain adaptations, however, the system outlined is applicable to other parts of the Dominion.—EDITOR.]

IT is becoming generally recognized that in order to obtain the maximum production of milk from a dairy cow adequate feeding is necessary, and that the feed produced by permanent pastures should be supplemented with hay and roots in the winter and green forages during the summer and autumn. The general trend of grass farming is in the direction of the substitution of long or short rotation grassland by more or less permanent pastures, which are kept in a productive state by judicious stocking and regular top-dressing with phosphate manures. The haying of permanent or long-rotation grass pastures is a bad practice, since it tends to destroy a close turf by eliminating much of the white clover and encouraging a tufty habit in cocksfoot.

The system of cropping here described includes special hay crops, and aims at concentrating the cropping on a portion of the farm and keeping the rest under permanent pasture. The rotation is as follows :—

First year : Italian rye-grass and red clover.
Second year : Italian rye-grass and red clover.
Third year : Roots and green forages.
Fourth year : Oats and vetches for hay.

Cropping Plan for a Herd of Sixty Cows (Area, 40 Acres).



NOTE.—Mangolds and carrots could alternatively be grown in Field 3 along with soft turnips and maize.

In the plan the areas under the different crops are intended to be approximate, and are based on the assumption that there are 60 to 65 acres of good average permanent pasture available for the dairy herd.

ITALIAN RYE-GRASS AND RED CLOVER.

The stubble, after oats and vetches for hay, is ploughed in January and worked down to a fine, firm seed-bed for sowing 25 lb. of Italian rye-grass and 5 lb. of red clover per acre in February or March. In the first year the field produces a large amount of winter and early spring feed. The field is cut for hay in December, yielding about 2 tons of hay per acre. During January the red clover comes away well and can be utilized for grazing, or a cut of red-clover hay can be taken. In the second year the field is shut up as for hay, and the growth being mostly red clover the crop can be held over for feeding in January, which is often a critical month. Part of the winter hay and roots and most of the green feed should be fed out on the rye-grass and clover fields, so as not to exhaust the soil of plant food and vegetable matter. The rye-grass should not be allowed to grow too rank in the winter, or the red clover will be partially smothered.

ROOT AND GREEN FORAGE CROPS.

Preparation of Land.

On heavy land the rye-grass and clover pasture is best ploughed in the early winter, thus allowing it to weather and break down during the cold months, then cross-ploughed in the spring and worked down to a fine firm seed-bed. The spring-toothed cultivator is one of the best implements in obtaining a good seed-bed on heavy land, as it brings the clods to the surface where they can be dealt with by the Cambridge roller, and at the same time it shakes the fine soil to the bottom, where it makes a continuous layer with the unmoved subsoil, through which water from the moister layers can rise to the surface. On a lighter soil the deep ploughing can be left till the spring, but the turf should be broken up a few weeks before the deep ploughing, either by skim-ploughing or a heavy disking.

Mangolds.

Mangolds can be grown on most soils other than those of a thin hungry nature, but do best in deep loams well supplied with vegetable matter. They give a higher yield and better food value than swedes—keeping well on into the spring, and providing an excellent feed for cows to milk on when grass is scarce. Sow in October 4 lb. to 6 lb. of seed per acre, in 28 in. drills, either on ridges or on the flat. Mangolds respond well to intensive intercultivation with the horse-hoe, and when grown on ridges the work can be begun much earlier than when they are planted on the flat. The Long Red variety is a heavy cropper and is suited to heavy land; also it is the hardiest sort, but does not keep as well as the Globe varieties. Yellow Globe and Prize Winner Yellow Globe are standard sorts, giving good yields and keeping well; Jersey Queen is a variety that is becoming fairly popular.

Any well-rotted stable manure that is available should be spread on the land before ploughing. Apply artificial fertilizers at the rate of 4 cwt. to 8 cwt. per acre. The mixture should depend to some extent on the class of soil, though it usually is a complete manure that gives the best results. For a deep loam well supplied with vegetable matter the following general mixture is suitable: Superphosphate, 4 parts; sulphate of ammonia, ½ part; kainit, 2 parts. On light soils superphosphate could be replaced with basic super, or part of the super replaced by rock phosphate and the sulphate of ammonia with blood-and-bone. If kainit is not used, 3 cwt. to 5 cwt. of agricultural salt should be applied before sowing.

Before feeding, mangolds must be lifted and stored in a clamp to ripen. If fed while still growing or in an unripened state they are liable to cause scouring, and many instances of tympany and abortion have occurred through feeding green mangolds. If they are not stored in a pit they must be pulled and allowed to lie a fortnight at the very least before feeding. It is advisable to pull the tops off and leave them in the field, as they are of poor feeding-value, though they contain considerable amounts of manurial constituents. In feeding, 40 lb. to 50 lb. per beast per day, together with hay, is a sufficient ration. In the spring, if mangolds in the pit happen to be growing, they should be fed carefully. An average yield is 35 tons per acre, but with good cultivation and liberal manuring the yield should be 50 to 70 tons per acre.

Carrots.

Carrots make a splendid forage for milking-cows in the late autumn and early winter. Best results are obtained from a deep sandy loam with a free subsoil. Sown in 14 in. drills and unthinned, 1 lb. of seed is sufficient. In 21 in. or 28 in. drills sow 2 lb. to 2½ lb. of seed and hand-thin. It is a good plan to mix the seed with damp sand several days before sowing, in order to induce the seed to germinate and so get ahead of the weeds. Sow the crop at the same time as mangolds, substituting ½ cwt. of sulphate of potash for the kainit.

The red varieties are slightly more nutritious than the white, Sinclair's Champion and Magnum Bonum being the varieties usually sown. White Belgian is a heavy yielder and grows high out of the ground. Matchless White is a heavy yielder and easily lifted. Crops of 20 to 25 tons can be easily grown on fairly poor light soils with moderate manuring, while on good soils much larger crops can be produced. A ration of 30 lb. to 35 lb. per day is sufficient.

Swedes.

If time cannot be spared for the cultivation of mangolds or carrots, swedes will have to take their place. Swedes are of slightly lower feeding-value than mangolds, and even when they keep through the winter cannot be fed when the cows come into milk in the spring. The Purple and Bronze Top varieties are considered to produce the largest yields, while the Green Top varieties are said to be of the higher feeding-value. Of the Purple Top varieties, Garton's Superlative has given excellent results; Crimson King, Magnum Bonum, Monarch, Elephant, and Best of All are good varieties. Phosphatic manures are

essential for swedes, and at least part of the phosphates should be soluble. On good loams use 2 cwt. to 3 cwt. of super, basic super, or a mixture of equal parts of super and rock phosphate or super and slag. On poorer soils use a mixture of super and bonedust or blood-and-bone. On many light soils swedes do not do well, and soft turnips can take their place for autumn and early winter feeding. Imperial Green Globe is one of the best soft turnips for late use, as it keeps well and yields a good crop.

In choosing the most suitable root crop for winter feeding the farmer will be guided by his type of soil, climate, and the labour available for handling the crop. Where time can be spared for the thorough cultivation of root crops, mangolds and carrots should be grown. By mixing ½ lb. of carrot-seed in the mangold crop fair results are obtained. The carrots can be used for autumn and winter feeding, and the mangolds for late winter and early spring.

Soft Turnips.

In districts where soft turnips are allowed to be fed to milking-cows in February and March, sow about the first week in November an area of Purple Top Mammoth, Lincolnshire Red Globe, or Devonshire Greystone for early use, and Imperial Green Globe for late feeding. Drill in 14 in. rows, using 8 oz. to 12 oz. of seed and 2 cwt. to 2½ cwt. of the same manures as for swedes. When feeding turnips to milking-cows they should be pulled the previous day, allowed to wilt in the sun, and fed out in a clean grass-paddock immediately after milking. A ration of 30 lb. to 50 lb. per cow is sufficient. Where turnips are not used the area in maize or millet should be increased, and feeding commenced about the middle of February.

Maize.

From the beginning of March to the end of April green maize is the best cow-feed that can be used. Sown towards the end of November maize is ready for feeding out towards the end of February, although not mature until about the middle of March. Hickory King, Ninety Day, and Early Red Hogan are suitable varieties. The crop may be planted in rows, a few seeds at a time, 2 ft. 6 in. to 3 ft. apart; 30 lb. to 40 lb. of seed is sufficient to sow an acre. The crop should be horse-hoed at intervals until the plants are too high for the horse to get through. Maize may also be sown in 14 in. drills, using about 120 lb. of seed per acre, or in 28 in. drills, using 50 lb. to 90 lb. of seed. An average crop produces 20 to 30 tons of green feed. The weight of forage and feeding-value of maize can be greatly increased by sowing 30 lb. to 40 lb. of spring tares with it.

Japanese Millet.

For cutting and feeding out in March and April millet is not so useful as maize, as it only produces 15 to 20 tons of green feed per acre. It has the advantage that it can be grazed by cows earlier in the season. Millet sown about the middle of November reaches maturity towards the middle of March, when it attains a height of 5 ft. to 6 ft. The field, however, can be divided into breaks and the millet fed off when it is about 10 in. to 12 in. high. It will usually produce three

consecutive growths. The herd is allowed to graze on the millet for about two hours morning and evening. Sow 15 lb. of seed in 7 in. drills, mixing the seed with 2 cwt. to 3 cwt. of equal parts of super and blood-and-bone. If broadcasted 20 lb. to 24 lb. of seed is required.

Sorghum.

The sorghums are suited to a warm climate, and as a feeding-out crop are not as suitable as maize. The immature and second growth after cutting is dangerous to feed on account of some liability to prussic-acid poisoning. The crop is sown towards the end of November, using 25 lb. of seed in 28 in. drills, and harvested when the crop is in full bloom. An average yield is 20 to 30 tons per acre.

OATS AND VETCHES FOR HAY.

As the turnips are pulled and the maize cut and carted out, the land should be ploughed and worked down for sowing oats and vetches. The first sowing on the land occupied by soft turnips and early-fed maize should be made in April, and a later sowing in early May. Sow one bushel of Algerian oats and one bushel of winter vetches, with 1 cwt. to 2 cwt. of superphosphate or basic super. The crop should yield 3 to 4 tons of hay per acre.

Any portion of the field not sown in the autumn could be sown with oats and spring tares in August for hay, or in October for green feed in January.

FEEDING THE CROPS.

Of the 40 acres under crops in the plan, 16 to 20 acres are temporary pasture. The rye-grass and clover pasture in the first year should yield 20 tons of hay, and the area in oats and vetches 30 tons of hay. The mangolds should yield 100 to 150 tons, the carrots 25 tons, the soft turnips 120 tons, and the maize 120 to 180 tons.

The feeding of hay and carrots should be commenced in June, with a ration of 30 lb. of carrots and 10 lb. of hay. In July, August, and September, and during cold wet weather in October, the supplementary ration should be about 14 lb. of hay and 50 lb. of mangolds. From the middle of October to the end of December feed is plentiful. During January the grass commences to dry off, and the red clover in Field 2, which has been shut up during the late spring and early summer, is available for feeding out, giving a ration of 30 lb. to 35 lb. per day. Where soft turnips are allowed the feeding should start early in February with a ration of 40 lb. to 50 lb. per day. During March turnips and maize are fed together, and in April and early May maize alone, giving a ration of 60 lb. to 90 lb. per day, depending on the feed available. Where soft-turnip feeding is not allowed the whole area of Field 3 should be put in maize or millet, to be used from the middle of February to the end of April. The clover in Field 2 should be used for January feeding, and the aftermath of Field 1 retained for early February feeding. Towards the middle of May carrots can be used for any supplementary feeding necessary.

SOME VARIATIONS.

The rotation given must, of course, be adapted to individual farms. Great variation in climate obtains in dairying districts, and only crops suited to particular localities should be grown. Only general

quantities of seed and manure can be given. A heavy seeding often gives much poorer results than a light one, as the plants, being too close together, become stunted. In a loose seed-bed more seeds become buried and fail to germinate than in a well-consolidated one. Heavy land as a rule requires more seed than light.

Paspalum Farming.

There are many places where the system of crop rotation outlined is not applicable, the most typical example being the North Auckland peninsula, where on many farms the principal pasture grass is paspalum. On such farms (when situated on heavy flat land) the usual system of management is to allow the rank summer growth of grass to remain in the fields and to winter the cows on dry paspalum, with usually a run off on to hill country either in mixed grasses or danthonia or brown-top. The essential feature of this class of farming is understocking—gauging the carrying-capacity by the feed produced in the winter together with the old paspalum growth. When a paspalum field becomes sod-bound it is usually broken up in the autumn, fallowed in the winter, and in the spring sown in maize for grain. The high growth of paspalum and the dry maize are fed off in the winter and early spring. The field is then either left to go back to paspalum pasture or it is sown in rye-grass and cocksfoot in the autumn. Sometimes two or three crops of maize are taken. On the lighter soils and loamy clays the sod is sometimes broken up in the early autumn, and sown down to Italian rye-grass and red clover in March or April.

Such a method of farming is fairly satisfactory where the farmer has plenty of land and understocks; but calving must necessarily be late and the milking season shortened. As the land becomes more closely settled proper provision of feed for winter and early spring will have to be made to obtain adequate returns. The first step in this direction is the cutting of the excessive summer growth of paspalum for hay for winter and spring feed. By keeping the rank growth cut the maximum summer production of grasses is obtained, and the cows have always the fresh young feed to graze on. The next step is the systematic rejuvenation of paspalum fields with rye-grass mixtures, and the provision of a small area of mangolds for late winter and early spring use.

On farms in the North Auckland district in good cocksfoot, rye-grass, and clover pastures very little supplementary cropping is necessary if a specified area is devoted to paspalum. By keeping the paspalum low by grazing, or mowing if the growth is excessive, the grass does not spread to any extent, providing a close turf is maintained on the other pastures by chain harrowing and top-dressing. In most inland places 80 to 100 miles south of Auckland City, and in the coastal regions of the North Island generally, paspalum could also be utilized for part of the summer feeding.

Green Cereals, and Lucerne.

Cereals for winter feed: With an adequate supply of roots and hay, and temporary pastures of Italian rye-grass and red clover, green cereals for winter and early spring feed are not necessary. Under certain systems of cropping where swedes are the chief root crop,

however, Algerian oats sown in April are a useful crop for supplementing pasture in the early spring.

Lucerne: Where the land is really suitable lucerne should be grown for green summer feed and hay. On very small farms an area of lucerne is almost essential for successful dairying.

CONCLUSION.

The exact ratio of the area of land under supplementary crops to that under permanent pasture will depend on many factors—such as the area of the farm, climate, and the price and fertility of the land. The final determination can be made only by the farmer himself. The aim of this article is merely to show approximately what amount of supplementary cropping is necessary, under ordinary conditions of season and climate, to enable the carrying-capacity of average permanent pasture land during the months of its greatest growth to be maintained throughout the year.

COCKSFOOT-SEED PRODUCTION.

SUCCESSFUL TRIAL OF THE DANISH SYSTEM AT ASHBURTON EXPERIMENTAL FARM.

F. E. WARD, Instructor in Agriculture, Christchurch.

A TRIAL in the production of cocksfoot-seed on the Danish system of intercultivated rows at the Ashburton Experimental Farm has given very successful results. The plot is of 2·4 acres, of medium loam with stony patches. A crop of Dun oats was taken off it in 1920, after which the stubble was ploughed and the plot given three strokes with the grubber in the spring, tine-harrowed twice, rolled twice, and sown in 24 in. rows on 20th October (1920). The seed was imported Danish seed from a commercial line. No manure was used. The stand was horse-hoed three times and hand-hoed twice between November and February, owing to the excessive growth of fat-hen. Seed-stems appeared in March, 1921. The plot was stocked on 20th March with 40 lambs, and on 8th April an additional 160 were put on. They were all removed two days later. The field was then horse-hoed, harrowed, and closed for seed.

The cocksfoot stand was infested with grass-grub, especially in the light patches. These portions were heavily rolled in June and came away again, maturing somewhat later than the main crop. The seed was harvested on 24th December, 1921, the total yield being 713 lb. of undressed seed, or 297 lb. per acre. Double heads were very noticeable in the seed-sample, owing to the unripe condition of the grub-infested areas. The sample was an exceptionally good one, with a germination of 87 per cent., and weighing 18 lb. per bushel.

On being machine-dressed the following results were obtained on the total crop: Dressed seed, 557 lb.; glumes, 14 lb.; glumes and chaff, 60 lb.; straw, oats, &c., 6 lb.; double-heads, 34 lb.; weed-

seeds and kernels, 30 lb.; goose-grass, hair-grass, &c., 12 lb.: total, 713 lb.: loss in weight on dressing, 22 per cent.

The average yield from Akaroa hill-paddock crops is about 170 lb. per acre, with a germination of 63 per cent. and a weight of 15 lb. per bushel. A privately owned stand in the Waikari district, considered commercially to be above the ordinary, yielded on an average for two years 261 lb. per acre, with a germination of 82 per cent. and a weight of 18 lb. per bushel. The three crops are here compared:—

Crop.	Yield per Acre.	Weight per Bushel.	Germination.	Remarks.
	lb.	lb.	Per Cent.	
Danish, sown in 24 in. rows and intercultivated	297	18	87	First cut; stand fourteen months old.
Waikari district, broadcast	261	18	82	Average of two seasons, established stand.
Akaroa, natural	170	15	63	Average commercial seed.

The trial thus indicates that the growing of cocksfoot on the Danish system compares favourably with the ordinary New Zealand method, and that it could be employed to advantage more generally on arable land. A remarkable feature of the Ashburton Farm crop lies in the fact that it was harvested in fourteen months from the sowing of the stand. It is intended to follow up this first season's test, and to record subsequent comparative data in greater detail.

FIG. 1. THE COCKSFOOT-SEED CROP AT ASHBURTON EXPERIMENTAL FARM.

Photo taken on 6th December, 1921—under fourteen months from date of sowing. The rows do not show from this viewpoint.

APPLE AND PEAR BLACK-SPOT:

THEIR APPEARANCE, CAUSE, AND CONTROL.

G. H. CUNNINGHAM, Biological Laboratory, Wellington.

(1.) APPLE BLACK-SPOT, *VENTURIA INAEQUALIS* (CKE.) ADERH. Syn.—*Sphaerella inaequalis* Cke.; *Venturia Pomi* (Fr.) Wint.; *Venturia inaequalis* (Cke.) Wint.; *Fusicladium dendriticum* (Wallr.) Fcl. Apple-scab.

EXCEPT in favoured localities where the humidity is low during the growing season, such as in Central Otago and certain localities in Marlborough and North Auckland, black-spot is common on apples throughout New Zealand. It occurs also in Australia, South Africa, North America, and Europe.

In New Zealand the conidial or summer stage appears in the form of dark-coloured spots on the leaves, fruits, and shoots. The ascigerous or winter stage occurs as a saprophyte, the perithecia developing in the spring from mycelium which has wintered over in dead leaves. This stage does not occur on fruits or shoots, being found only in the tissues of the dead leaves.

Apple black-spot is not confined to the cultivated apple (*Pyrus malus* L.), since in Europe and North America it has been recorded on related species of the genus *Pyrus*. For example, in North America it occurs on the wild crab (*Pyrus coronaria* L.). It is unable to infect hawthorn or pear, the black-spot of these hosts being caused by related species.

ECONOMIC IMPORTANCE.

Black-spot is the most serious apple-disease with which the orchardist has to contend, as it not only weakens the tree by damaging the leaves, but reduces the market value of the fruit through the development of disfiguring spots, scabs, and cracks on the epidermis. In cases of severe infection the crop may become a total loss, owing to the developing fruits being so damaged as to fall to the ground at the time of setting or shortly after. The defoliation following upon severe leaf-infection impairs the following season's crop, as the development of fruit-buds is largely dependent on the leaves of the previous season. As a result of fruit-infection loss may be caused in four ways:—(1) The fruits may fail to set owing to their being killed outright by the fungus; (2) as a result of infection young fruits may fall to the ground; (3) young fruits may become distorted, badly scabbed, or cracked, and thus be rendered unsaleable; (4) the quality of the fruit and its keeping properties may become impaired by the development of disfiguring marks on the surface.

In the last case the disease does not result in the rotting or breaking-down of the tissues of the apple, as is the case with bitter-rot and other similar fruit-rotting fungi. On the contrary, the most noticeable effect may be a mere superficial disfigurement of otherwise mature and healthy fruit; nevertheless, this defect in quality is often enough in itself to render a large portion of a crop unsaleable. Serious as this may be, it is by no means the worst feature of black-spot; in several ways it may directly reduce the quantity of fruit. This aspect of the

disease is more liable to pass unnoticed, but it is immeasurably more disastrous in its results. Black-spot thus affects the quantity as well as the quality of the output—the two factors on which the profit of the orchardist depends.

FIG. 1. LEAF-INFECTION: DOUGHERTY APPLE LEAF WITH LESIONS ON UPPER SURFACE. NATURAL SIZE.

FIG. 2. PETIOLE-INFECTION, SHOWING SMALL CANKERS WHICH ARE FORMED AND CAUSE PREMATURE LEAF-FALL. × 6.

[*Photos by E. Bruce Levy.*

APPEARANCE AND EFFECT ON THE HOST.

Black-spot makes its appearance on the leaves about the first week in November, the exact time varying with the blossoming-period of the host variety (Fig. 1). It is not generally observed in this early stage, owing to the spots being small, scattered, and situated chiefly on the under-surface of the leaf. Their occurrence in this position is due to the fact of the under-surface being first exposed as the leaf emerges from the bud. The spots are olivaceous in colour, and have at first a somewhat indefinite outline, owing to the hyphæ of the fungus

radiating outwards from the source of infection. Though few at first they may later increase in numbers, until the whole leaf-surface becomes covered with small spots, which grow until their margins meet, so that ultimately nearly the whole surface may be involved. Sometimes the portion of the leaf-tissue below these spots becomes upraised and presents a bullate or blistered appearance, the other surface becoming correspondingly depressed or concave. The spots on the lower surface are usually more irregular in outline than those of the upper surface, and tend to follow the direction of the main veins. The leaf-tissues under the centre of the old spots are often killed outright, when they assume a brown colour and occasionally fall away, leaving perforations in the leaf. Infected leaves frequently become incurved or distorted, generally remain smaller in size, and usually fall prematurely, so that in a season when black-spot is prevalent the trees may become completely defoliated. On the petioles small cankered areas are formed which cause the death of infected tissues, followed by premature leaf-fall (Fig. 2).

Black-spot first appears on fruits shortly after they have set, when it shows on the calyx and pedicels, but not on the petals. When pedicels are infected the young fruits as a rule fall off, their further development and nutrition being prevented by the hyphæ of the fungus. When spots appear on the calyx distortion of the fruit usually follows, the parasitized cells being damaged to such an extent that they are unable to develop further, and as growth continues in the cells in their vicinity misshapen fruits result. Such distorted fruits commonly fall, as owing to unequal growth they come into contact with other developing fruits, and are forced from the spur to which they are attached. On maturing fruits the spots appear as olivaceous more or less circular areas, surrounded by greyish edges formed from the marginal portion of the undissolved part of the cuticle, which has been forced apart from the epidermal cells by the invading hyphæ (Fig. 3). Fruit-infection usually occurs at the calyx end, as this is the area most exposed to moisture and the wind-borne spores. After infection the spots continue to enlarge in a circular manner; then after a time their centres usually become exposed, as the spores are carried away by wind or rain, when they appear as brownish russeted areas (Fig. 4). On actively developing fruits the spots become depressed or sunken (Fig. 4). This is due to the fact that immediately beneath the spots corky tissue is formed, which is hard and unyielding, growth of the host tissues being thus prevented in this region, while the surrounding healthy tissues continue their development beyond it. These spots may coalesce, and after the spores have disappeared the internal pressure of the developing host cells often causes the formation of large

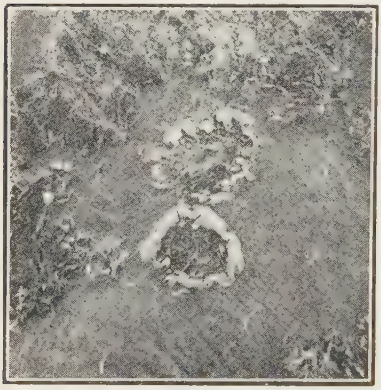


FIG. 3. FRUIT-INFECTION: LESIONS SURROUNDED BY UPRAISED CUTICLE. × 10.
[Photo by E. Bruce Levy.

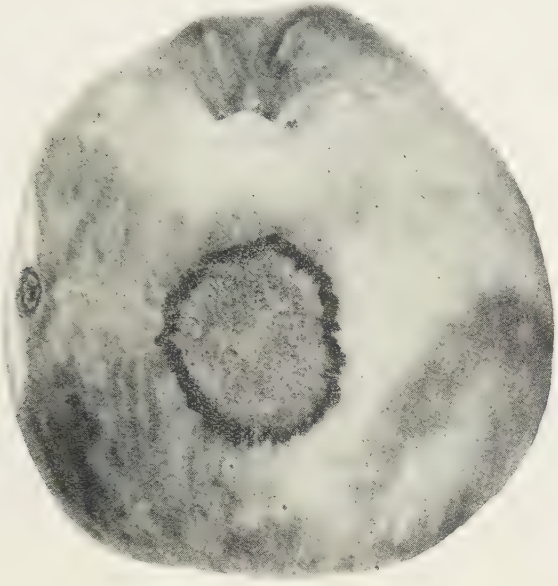


FIG. 4. EARLY INFECTION ON DELICIOUS APPLE. NOTE LARGE SIZE OF SPOT AND RUSSETED AREA IN CENTRE. NATURAL SIZE.

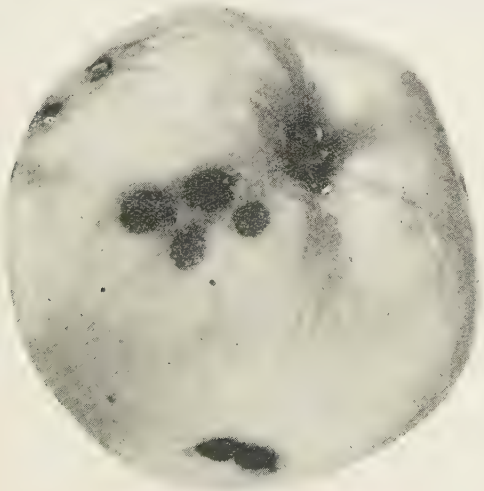


FIG. 5. LATE INFECTION ON DOUGHERTY APPLE. NOTE SMALL SIZE OF LESIONS. NATURAL SIZE.

[Photo by E. Bruce Levy.

cracks, which afford opportunity for the entry of the spores of fruit-rotting fungi.

When late infection occurs on mature or nearly mature fruits the spots are as a rule minute, and the fruits do not show any depressed areas or russet-marks (Fig. 5). Black-spot development may continue in cool store, spots in this case presenting large greyish borders surrounding intensely black centres (Fig. 3). The intense coloration is due to the masses of dark-coloured spores, which in the still atmosphere of a cool store are not carried away, but remain where they are formed.

Shoot-infection varies somewhat in appearance according to the host variety attacked.* On certain varieties the epidermis of young shoots may be studded with light-brown spots consisting of blister-like pustules containing conidia in their centres (Fig. 6). In other varieties infected shoots are somewhat swollen and blistered, the bark ultimately

FIG. 6 (UPPER). APPLE-SHOOT INFECTION: PUSTULES ON DOUGHERTY LATERAL. × 6.

FIG. 7 (LOWER). APPLE-SHOOT INFECTION: LESIONS ON WOOD SIMILAR TO THOSE FORMED ON FRUITS. DOTTED OUTLINE SHOWS SIZE OF LESION. × 6.

[*Photo by E. Bruce Levy.*

peeling off in flakes; or lesions resembling those on fruits may be formed (Fig. 7). Vigorously growing shoots and water-shoots appear to be more readily attacked. These lesions tend greatly to weaken the shoots and render them liable to fracture; moreover, they facilitate the attacks of apple-canker, black-rot, and other canker-forming fungi.

LIFE-HISTORY OF THE CAUSATIVE ORGANISM.

Apple black-spot is caused by the ascomycetous fungus *Venturia inaequalis* (Cke.) Aderh. The conidial stage of the latter, long known

* Apple-shoots infected with black-spot were recently obtained at Mapua by Mr. J. Thorp, Orchard Instructor, and the writer. This stage is not uncommon on several varieties, appearing near the tips of laterals.

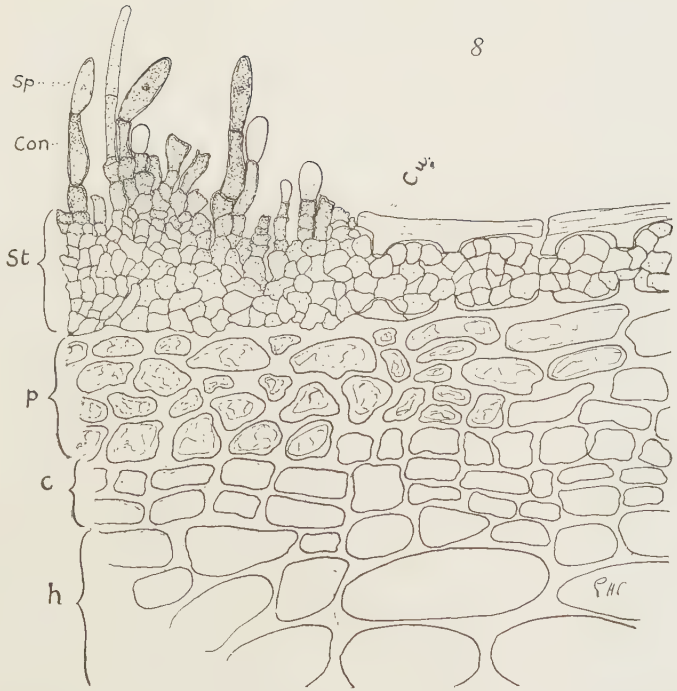
as *Fusicladium dendriticum* (Wallr.) Fcl., is the active agent, the ascigerous stage being merely saprophytic, occurring on dead leaves. Nevertheless, it is mainly this saprophytic stage that spreads the disease afresh each season.

In early November black spots begin to appear on leaves and developing fruits, arising as a result of infection either from ascospores produced from perithecia formed in dead leaves or from conidia produced from stromata which have overwintered on shoots.

If a spore (ascospore or conidium) alights on a leaf or fruit surface, and conditions prove favourable, it germinates and produces a germ-tube, which penetrates the cuticle, beneath which it branches repeatedly to form a mycelium, which derives its nourishment from the solution of the cuticle and from cells of the epidermis or parenchyma lying immediately beneath. About a fortnight after infection this mycelium develops a stroma consisting of closely woven masses of hyphæ (Fig. 8, *st*); from it upright hyphæ (conidiophores) are produced, arranged in closely packed columnar masses (Fig. 8, *con*); on their apices the olive-coloured elliptical conidia are produced (Fig. 8, *sp*), being cut off in succession from the conidiophores. During the development of the stromata and conidiophores the cuticle is gradually forced away from the epidermis, and at this stage appears as a greyish border surrounding the spore masses (Fig. 3). The conidia are readily detached, and being light are carried by wind or other agency to neighbouring leaves or fruits, which in turn may become infected. Conidia remain viable for but a short time, so that subsequent infection must occur from conidia produced throughout the season from stromata on leaves, fruits, or shoots.

Infected leaves sooner or later fall to the ground, where they become permeated with the dark-coloured mycelium. In the autumn perithecia begin to form from this mycelium, but do not reach maturity until after the winter months, their development being completed in August and September. A perithecium is a flask-shaped receptacle the walls of which are formed of closely woven hyphæ (Fig. 9). In its early stages it is filled with hyphal filaments, certain of which later develop into asci (Fig. 9, *a*), each containing eight two-celled ascospores.* The ascospores at first are colourless and unicellular, but at maturity they become unequally septate and yellowish-green in colour (Fig. 10, *as*). During development the perithecium is completely buried within the leaf, but as it reaches maturity it approaches the leaf-surface until the neck, which is perforated with a minute opening (the ostiolum, Fig. 9, *os*), pierces the epidermis and opens on to the free surface (usually the lower) of the leaf. As the perithecium matures, the neck, which is at first smooth, becomes crowned with a few coarse black bristles (Fig. 9, *br*). Perithecia, as a rule, develop only on leaves that have been somewhat protected during the winter months; leaves found under hedges, clods, &c., contain numerous

* Prior to the formation of the perithecium sexual union occurs. This is a device on the part of the organism to prevent degeneration, and doubtless plays an important part in the production of an actively parasitic strain.



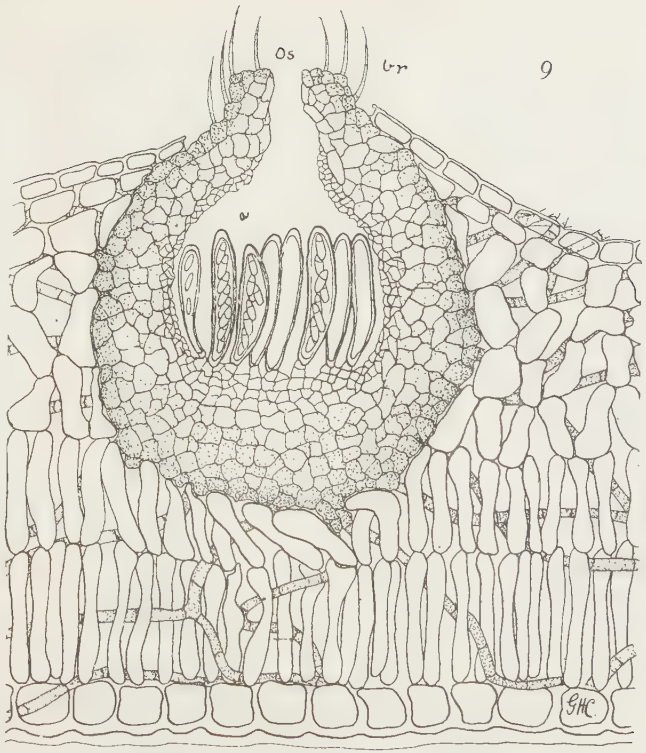


Fig. 8. Fruit-infection: Section through lesion on fruit—(*c*) cambium; (*con*) conidiophores; (*cu*) cuticle; (*h*) healthy parenchyma; (*p*) plasmolized cells affected by the fungus, brown in colour; (*sp*) conidia; (*st*) stroma formed of closely woven hyphæ. × 375. Camera lucida drawing.

Fig. 9. Section through leaf containing perithecium opening on to lower surface—(*a*) asci; (*br*) bristles; (*os*) ostiolum. × 340. Camera lucida drawing.

[*Original.*

perithecia, while those lying exposed on wet ground have few or none. From the middle of September until the first week in December, on the occurrence of rainy weather, the ascospores are discharged from the perithecia into the air, being ejected sufficiently high to be caught in and carried by air-currents to developing leaves and fruits in the neighbourhood. The discharge of ascospores is dependent on the presence of abundant moisture, which causes certain portions of the asci and perithecia to swell to such an extent that the enclosed asci are subjected to considerable pressure, this forcing out their contained ascospores through the perithecia into the air. So great is the pressure developed by the swelling of these hygroscopic portions that the entire perithecium is sometimes shattered, asci and spores being ejected into the air with considerable force, the embedded base of the perithecium alone remaining in the leaf-tissues. Not only is abundant moisture essential for the discharge of the ascospores, but it must also be present on the leaves before an ascospore can germinate or its germ-tube pierce the cuticle.

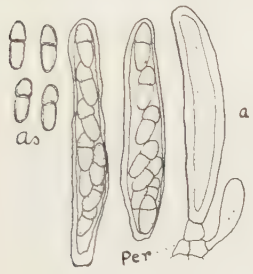


FIG. 10. ASCI AND ASCOSPORES.

(*a*) Asci; (*as*) ascospores; (*per*) portion of perithecium to which asci are attached. × 400. [*Original.*

When an ascospore germinates it produces a germ-tube (usually two are produced, one from each cell), which penetrates the cuticle, beneath which it branches repeatedly, giving rise to a stroma on which conidia are produced. The production of conidia thus completes the cycle.

The fungus may winter over on infected shoots, when in spring it produces conidia capable of causing leaf, fruit, and shoot infection as soon as leaves appear.

(2.) PEAR BLACK-SPOT, *VENTURIA PIRINA* ADERH.

Syn.—*Fusicladium Pirinum* (Lib.) Fcl. Pear-scab.

This disease is very similar in appearance to apple black-spot, and by orchardists is usually regarded as identical. The causative organism differs in several details of structure of the fructifications, as well as in its inability to infect any host other than the pear. It causes a leaf and fruit spot similar in appearance to apple black-spot, while its life-history and control are similar. It differs from apple black-spot in that it commonly produces conidia on young shoots and laterals (Figs. 11, 12), a condition known for the past fifteen years to exist in New Zealand. The writer has shown elsewhere that conidia have been produced continuously on shoots over a period of nine months, and that viable conidia occurred on shoots during the whole of that period. There is therefore little doubt that with this species shoot-infection is one of the means of carrying the organism over the winter months. The fact must not be lost sight of, however, that perithecia are produced abundantly on fallen leaves, and that the ascospores so produced are quite capable of infecting the leaves and fruits of this host in the spring.

GENERAL CONSIDERATIONS.

From the foregoing it becomes apparent that black-spot is carried over the winter by mycelium embedded in the dead leaves and by mycelium overwintering in infected shoots. We have seen that from this mycelium in the dead leaves perithecia containing ascospores are developed in the spring. We know that these ascospores, which are discharged some time prior to, during, and for a short time after blossoming, are one of the sources of primary infection, and that when they infect leaves or fruits they give rise to mycelium from which conidia are produced, these conidia in turn causing infection throughout the season. Furthermore, we have seen that from mycelium embedded in infected shoots are produced conidia which are capable of producing the disease as soon as the leaves and fruits appear.

FIG. 11 (UPPER). PEAR-SHOOT INFECTION. USUAL FORM. NOTE BLISTERED AREAS. × 6.

FIG. 12 (LOWER). PEAR-SHOOT INFECTION. UNUSUAL CONDITION SHOWING DEPRESSED AREAS. × 6.

[*Photo by E. Bruce Levy.*

Thus it would appear that in order to enable the control of the disease to be carried out we must either (*a*) prevent primary infection by the destruction of leaves containing perithecia, and deal with shoot-infection in such a manner that formation of conidia is prevented, or (*b*) prevent ascospore and conidial infection by covering developing foliage and fruits with a protective spray.

(*a.*) If the fungus were perpetuated by ascospores alone, then the destruction of all leaves containing perithecia would prevent primary infection, clean fruit would result, and spraying would be unnecessary. Unfortunately, this would be impossible in orchard practice, as leaves containing large numbers of perithecia commonly occur in such places as under hedges, &c., where they cannot be buried by the plough. Destruction of fallen leaves by hand would be impracticable, owing to the time that this would take and the labour that would be required. Doubtless, infection is minimized by the destruction of a large proportion of the leaves, so that where possible cultural operations should be carried out before ascospore discharge begins in the spring—that is, before September.

Even if the destruction of fallen leaves were practised, infection would still be liable to occur from the conidia developed on infected shoots. The cutting-out of these would not be entirely satisfactory, as this treatment would require a modification of the present lateral system of pruning, and would, moreover, necessitate the examination of every shoot, an operation which would be impracticable in a commercial orchard during pruning operations.

(*b.*) If ascospore discharge occurred during a short period only, then a single spray application at this time would be all that was necessary to combat this phase of black-spot infection. Unfortunately, spore-discharge occurs over a period of weeks, beginning some time before blossoming and continuing for some time after. Infection does not cease with the completion of ascospore-discharge, but continues throughout the whole of the growing-period and afterwards, occurring even in cool store. Throughout the season conidia are being produced on leaves and fruits, and it is these that cause late infection, as they may be carried by air-currents for long distances. Thus, even an orchard that has been sprayed thoroughly during the blossoming-period is subject to infection from these wind-borne conidia. Spray applications, therefore, are necessary throughout the season to prevent infection. When fruit is to be placed in a cool store a spray application before picking will be of value in preventing infection while in the store.

To summarize: A series of spray applications is necessary, so that the danger period of ascospore infection may be effectively covered, conidia on shoots destroyed, and subsequent development of conidia on leaves and fruits prevented.

CONTROL.

(By J. A. Campbell, Director of the Horticulture Division.)

It has been shown in the foregoing matter that control of black-spot by destruction of infected leaves is impracticable, not only because of the difficulty of destroying all the leaves, but because the danger of infection from diseased shoots still remains. Nevertheless, as destruction of infected leaves would tend to minimize infection by reducing the number of ascospores, it should be practised wherever feasible. It would therefore be advisable to plough deeply in the autumn and dig under all portions left by the plough, thus burying as many leaves as possible. Orchardists are recommended to spray according to the following schedule, which has been found to control this disease effectively in the orchard districts of Auckland, Hastings, and Nelson.

Spray Schedule for the Control of Apple and Pear Black-spot.

No.	Time of Application.	Spray.
1	Green-tip	5–4–50 bordeaux, or 1–10 lime-sulphur.
2	Between open-cluster and pink stage	3–4–50 bordeaux, or 1–30 lime-sulphur.
3*	Calyx-spray (petal-fall; or when majority of petals have fallen)	1–100 to 1–120 lime-sulphur.†
4	Ten days later ..	1–100 to 1–120 lime-sulphur.
5	Every month until the fruit reaches maturity	1–100 to 1–120 lime-sulphur.
6‡	Immediately before picking ..	1–100 lime-sulphur.

* With this and subsequent sprays arsenate of lead, 3 lb. paste or 1½ lb. powder to 100 gallons, may be added for the control of codlin-moth and leaf-roller caterpillar.

† With some varieties 1–100 lime-sulphur is liable to scorch; in such cases the weaker mixture should be used.

‡ This application is required only when the fruit is to be placed in cool store for some considerable time, its object being the prevention of cool-store infection. It could be applied with advantage where the fruit was required for export.

This is but an empirical schedule, and will require to be modified somewhat according to the locality and variety. When in doubt the orchardist would do well to consult the Orchard Instructor for his district. It may be as well to stress the fact that it is the period and thoroughness of application, rather than the exact strength of the spray used, that is the governing factor in the control of black-spot.

The first four applications cover the period of ascospore infection; subsequent sprays are for the prevention of conidial (summer stage) infection. Lime-sulphur may be used throughout, particularly where a combined insecticide-fungicide is required; but better results will be obtained if the first two applications are of bordeaux mixture at the strengths given, this applying more particularly when the varieties are susceptible to black-spot or where trees have been badly infected the previous season.

LITERATURE CONSULTED.

ADERHOLD, R.—1894, Die Perithecienform von *Fusicladium dendriticum* Wallr., *Ber. Deut. Ges.*, Vol. 12, pp. 338–42; 1896, Die *Fusicladium* unserer Obstbaume. *Landw. Jahrb.*, 1 Tiel., Vol. 25, pp. 875–914; 1897, Revision der Species *Venturia chlorospora, inaequalis* und *ditricha* autorum, *Hedw.*, Vol. 36, pp. 66–83.

CLINTON, G. P.—1901, Apple Scab. *Univ. of Illinois, Agr. Exp. Stn. Urbana Bull. 67*, pp. 109–156.

COOK, MEL. T., and SCHWARZE, C. A.—1917, Apple Scab on the Twigs. *Phytopathology*, Vol. 7, pp. 221–22.

CUNNINGHAM, G. H.—1921, A Note recording the Presence in New Zealand of the Perithecial Stages of Apple and Pear Black-spot. *N.Z. Jour. Agr.*, Vol. 23, pp. 219–21.

CURTIS, MISS K. M.—1921, The Significance of the Development in New Zealand of the Perithecia of the Apple and Pear Black-spot Organisms, *N.Z. Jour. Agri.*, Vol. 23, pp. 215–18. 1922, Ascospore-ejection of the Apple and Pear Black-spot Fungi—Characteristics noted during the Season 1921, *N.Z. Jour. Sci. & Tech.*, Vol. 5, pp. 83–90.

HESLER, L. R., and WHETZEL, H. H.—1917, Apple Scab, *Manual of Fruit-tree Diseases*, New York, pp. 3–13.

KEITT, G. W.—1920, A Preliminary Report on Apple Scab and its Control in Wisconsin, *Phytopathology*, Vol. 10, p. 58.

MASSEE, G.—1910, Apple Scab. *Diseases of Cultivated Plants and Trees*, pp. 204–208, London.

MORSE, W. J., and DARROW, W. H.—1913, Is Apple Scab on Young Shoots a Source of Spring Infection ? *Phytopathology*, Vol. 3, pp. 264–269.

NICHOLLS, H. M.—1913, The Black Spot of the Apple and Pear. *Ag. and Stock Dept., Tasmania, 1913, Bull. 48*, pp. 1–15.

PARASITIZING THE WOOLLY APHIS.

PROGRESS OF THE WORK OF BREEDING AND DISTRIBUTION OF *APHELINUS MALI* IN NEW ZEALAND.

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IN a previous article in this *Journal* (July, 1921) I gave an account of the introduction into New Zealand of *Aphelinus mali*, a valuable parasite of the woolly aphis, from North America. In that article I showed how, from three males and two females bred from the parasitized material received from America in January, 1921, a total of 127 adult *Aphelinus* had been bred and placed out in various orchards up to the 3rd May, 1921, when the cold weather stopped all further emergences. The purpose of the present article is to take up the account of the work where the previous article left off, and to show the position at the present time.

With a view to the more intensive breeding of this parasite, the Cawthron Institute insectarium, built in November last, was designed with one room suitable for work with minute parasites. This room was closed in with phosphor-bronze wire-gauze measuring sixty meshes to the inch. The width of the adult male *Aphelinus* being about one-fiftieth of an inch, and the female a little stouter, it was necessary to secure gauze with a mesh as fine as this in order to confine the adults within the insectarium. Four young apple-trees were planted in large tubs and placed in the *Aphelinus* room, ready for the emergence of the parasite in the spring. Mr. A. Philpott, Assistant Entomologist of the Institute, took charge of this work during November and December, while I was away in Australia. He also effectively established colonies of woolly aphis on all four trees in the usual manner, by making cuts of the bark with a knife and placing small clumps of aphis around the fresh cuts.

By the time the first *Aphelinus* emerged from tree No. 5 in the Institute gardens (this being the tree on which they were originally placed early in 1921) the four trees in the insectarium showed a vigorous growth of aphis, due to the sheltered conditions under which they were being grown and the care taken to spread the aphis in every possible way. *Aphelinus mali* began to emerge on tree No. 5 on 10th November, 1921, and continued until the 19th, only six specimens being secured altogether. All these were taken and placed on tree No. 3, one of the special trees inside the insectarium. By

the end of December a numerous progeny of these six *Aphelinus* had appeared on tree No. 3. During January numbers of these were taken and placed upon the other three trees in the insectarium, while not a few migrated thither themselves by flying. *Aphelinus* continued to emerge throughout January, and by the end of the month were sufficiently abundant to allow of the collection of large consignments every two or three days, without the risk of destroying the supply entirely.

In order to get the best results with the parasite two plans were put into operation, as follows:—

(1.) It was decided to put out consignments in gardens in Nelson itself where there were apple-trees infested with woolly aphis which

APPLE-TREE COVERED IN FOR REARING OF APHELINUS MALI AT MR. MAISEY'S ORCHARD, REDWOOD'S VALLEY.

[*Photo by W. C. Davies.*

did not get the systematic treatment in spraying that trees in commercial orchards undergo. Such trees as these form one of the chief sources of reinfection of orchards from year to year, as they yield immense numbers of winged aphids during April, and these winged forms, drifting far and wide over the whole district, reinfect the clean orchards, however carefully the latter may have been sprayed during the year.

(2.) It was also decided, in dealing with commercial orchards, not to let the batches of *Aphelinus* go free at random, but only to liberate them on specially prepared trees. Such trees are intended to become the secondary distributing-centres of the parasite during the next summer. It will readily be recognized that it is beyond the power of two men, however hard they work, to cover New

Zealand with sufficient *Aphelinus* to make a definite mark against the enormous numbers of woolly aphis which occur in every orchard. These trees were to be prepared by enclosing them in a large cage covered with bird-proof wire netting on the sides and top, with the addition of scrim on the roof and around the windward side of the cage. Orchardists willing to lend trees for this purpose were also asked to keep these trees unsprayed, so that enough aphis might develop on them to allow of a plentiful supply of *Aphelinus* being bred out the following summer. Thus each protected tree would form a sort of local insectarium from which local distribution could be carried out, and also restocking made from the Cawthron insectarium when necessary.

It is pleasing to be able to record that a number of fruitgrowers' associations took up this work with keenness. Covered-in trees were prepared at Tasman (1), Mapua (4), and Redwood's Valley (1), in the Nelson District, and also at Hastings (3) and Christchurch (3). In this connection, we desire to thank Mr. J. H. Thorp, Orchard Instructor at Mapua; Mr. W. H. Rice, Orchard Instructor at Hastings; Mr. F. W. Cone, president of the Canterbury Fruitgrowers' Association; and all those gentlemen who set apart and covered in trees in their orchards, for the valuable assistance given in this work.

The following table gives the dates and numbers of individuals of *Aphelinus* in each consignment sent out from the Cawthron insectarium during the past summer. All consignments placed out in Nelson itself come under the heading of treatment of unsprayed trees not covered in; all the rest of the consignments were placed out on specially prepared trees.

Distribution of Aphelinus mali in New Zealand during the Summer of 1922.

Date.	Number sent out.	Locality.	Consignee.
Jan. 28 ..	80	Nelson ..	Cawthron orchard (Annesbrook).
Feb. 14 ..	40	Nelson ..	Mi s Pool.
Feb. 14 ..	200	Nelson ..	Colonel Burton.
Feb. 16 ..	80	Nelson ..	Mr. Duncan.
Feb. 18 ..	140	Nelson ..	Miss Davidson.
Feb. 20 ..	100	Nelson ..	Mr. Oldham.
Feb. 24 ..	240	Tasman ..	Captain Murray.
Feb. 25 ..	140	Nelson ..	Mr. Simpson.
Feb. 27 ..	160	Hastings ..	Mr. W. H. Rice.
Mar. 2 ..	200	Redwood's Valley	Mr. Maisey.
Mar. 6 ..	160	Christchurch ..	Mr. F. W. Cone.
Mar. 7 ..	140	Mapua ..	Mr. Coutts.
Mar. 9 ..	220	Hastings	Mr. W. H. Rice.
Mar. 13 ..	240	Christchurch ..	Mr. F. W. Cone.
Mar. 20 ..	200	Mapua ..	Mr. Thorp.
Mar. 27 ..	140	Christchurch ..	Mr. F. W. Cone.
Mar. 28 ..	100	Mapua ..	Mr. Thorp.
Mar. 30 ..	100	Hastings ..	Mr. W. H. Rice.
April 1 ..	80	Stoke	Mr. Pickup.
Mar. 4 ..	100	Mapua ..	Mr. Thorp.

Total distributed, 2,860 (Nelson Province, 1,840; Hawke's Bay, 480; Canterbury, 540).

It will readily be seen that the position of *Aphelinus mali* in New Zealand at the present time is a great advance on that of the previous year, nearly three thousand individuals having been reared and placed out under specially favourable circumstances. The work of rearing and distributing this parasite will be undertaken again next year in the same manner. It is hoped that every fruitgrowers' association in the Dominion will avail itself of the opportunity of obtaining supplies from Nelson, so that *Aphelinus* may become completely established throughout the fruitgrowing areas of the Dominion. It is now established that these tiny insects can be sent by post safely to any destination in New Zealand without appreciable loss in transit. Consignments will be sent out from the Cawthron insectarium to any association or orchardist who notifies us that he has a tree prepared in the manner indicated in this article, it being understood that each locality will, as far as possible, undertake the further distribution of the parasite in the orchards surrounding the prepared tree. Further trees will be placed inside the Cawthron insectarium during the winter, so that a larger supply of *Aphelinus* can be reared from them.

As a guide to the manner of covering in the trees in the cheapest possible way to be effective, a photograph is here given of the tree covered in by Mr. Maisey at Redwood's Valley. A crude doorway can be made at one side, if thought necessary, for entrance and exit; or it will suffice if the netting is simply hooked on, so that it can be unhooked and turned back when the tree is to be examined.

COOL STORAGE OF APPLES.

AN INVESTIGATION OF FLESH-COLLAPSE.

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[Paper read at the annual conference of the New Zealand Fruitgrowers' Federation, Wellington, June, 1922.]

FRUIT held in cool storage is liable to deteriorate from a number of different causes, and in order to perfect our methods of preserving fruit in this manner the various defects that are met with must first be sharply distinguished one from the other. Where it is possible this can best be done by a study of the nature of the primary causes.

BLACK-SPOT, "STING," AND SCALD.

In order to form some idea of the different natures of the diseases in cool-stored apples we may first briefly consider the well-known condition of black-spot fungus (*Venturia inaequalis*). There is no doubt that a certain amount of development of black-spot takes place in cool store. But further than this, judging by the very early infection that is met with, it is clear that perfectly sound apples can be attacked in cool store—that is, that black-spot can spread in such low temperatures. This is obviously a trouble that must not be attributed to the storage conditions; the remedy is to be applied before the fruit is picked.

Secondly, one meets in the cool store with a class of disease known as "sting." This term appears to cover a number of different conditions. Strictly speaking, it bears reference only to such injury as succeeds the punctures of insects. Popularly, however, sting is seen to be some form of rot or decay. Blue mould (*Penicillium*), bitter-rot (*Glomerella*), or botrytis (a fungus that in the field may set up rot in the eye of the apple) may be the cause of the rot, but the real cause of sting is due primarily to some form of mechanical injury to the skin. In this case the fungi do not spread in the store like black-spot, for the skin must be injured before they can set up infection. This, then, is another trouble that is instituted in the apple prior to its arrival at the store.

Thirdly, we may take another type of disease—scald. This disease is very striking in its appearance. It may appear as small up to very large dark sunken patches in the surface of the apple. The fruit may be almost covered with the disease, only a small portion at the stalk and eye ends remaining undamaged. The disease does not spread through the fruit like a fungus, nor does it spread from one fruit to another. It is not caused by a fungus but by vapours. Certain American investigations have shown that these vapours, known as esters, are given off by the apple, and that if they accumulate in sufficient quantities they are liable to produce the effect known as scald. This type of disease is due more to storage conditions than any we have yet considered. It is worse among apples packed in barrels. Satisfactory ventilation will disperse the vapours and prevent injury. The investigators, however, suggested another remedy, that of wrapping the fruit in oiled paper. This method has been tried out with success by the Biology and Horticulture branches of the Department of Agriculture.

The fourth type of disease consists in those whose cause is still unknown. This brings me to a special form of injury to which I have given some attention.

FLESH-COLLAPSE DISEASE.

Recently cabled reports have appeared in our local papers referring to shipments of Tasmanian and Australian apples which have opened up in England in bad condition. The important feature of the trouble as reported was that while the outside of the fruit showed no sign of injury the inside was browned. Other reports have stated that "brown-heart" is very prevalent in the shipments.

I believe that these troubles will be found to be identical with an important disease affecting cool-stored apples in New Zealand. In the first place this local disease may be clearly distinguished from scald and all other surface injuries by the fact that the skin remains undamaged until the last stage of the disease. This, in fact, is one of its characteristic features. Beneath the skin it may appear in various degrees of severity. It may occur merely as a narrow band of pinkish-brown soft flesh running parallel with the skin. The brownish condition, however, may involve a much larger portion of the flesh; in fact, the whole of the interior may be thus damaged, while the skin shows little or no signs of injury. Microscopic examination of the flesh shows that the cells are collapsed. We in New Zealand have therefore come to know the disease as "flesh-collapse." Affected apples when squeezed in the hand are not firm, but abnormally

springy. As a result of the damage thus sustained fungus rots may subsequently set in and discoloration of the skin finally make its appearance. This disease has already accounted for extensive losses in apples cool-stored in New Zealand, also for losses to our fruit after shipment to London. In my opinion, outside of orchard practice, the question of paramount importance to the success of our apple export trade is how to prevent the development of flesh-collapse.

In November, 1920, I was instructed to take up the study of flesh-collapse. Many reasons were at that time suggested as the cause of the disease, and there was very little agreement in the opinions of different individuals. Only in two particulars was there any concurrence of opinion. Those persons, for instance, who were interested in the various cool stores inclined to the view that the trouble arose from certain conditions in the orchard. The orchardists, on the other hand, showed a strong tendency to claim that the cause of the trouble should be sought in the cool store. The real cause of the disease has not yet been demonstrated in any part of the world. We in New Zealand have certainly made some advance, inasmuch as we have shown that certain opinions as to the cause are wrong. My present purpose is not to dogmatize as to the cause of flesh-collapse, but rather to relate briefly the results of the work that has been done, and to show what I believe to be the most promising direction in which to seek a solution of this most difficult problem.

The various conditions that have been suggested as the cause of flesh-collapse will next be considered.

Weather: Drought followed by much rain was believed to result in a rush of sap that rendered the developing fruit susceptible to flesh-collapse. The trouble, however, was just as abundant in 1921 as in 1922, and the seasonal peculiarities must have been similar in both years if they were the cause; but this was not the case.

Lack of cultivation: It is quite clear that if the weather condition had exerted a bad influence on the fruit, then a sufficiency of cultivation might certainly have done much to equalize any excess or deficiency in soil-moisture. Apples, however, were shown to develop flesh-collapse despite liberal cultivation.

Maturity of the fruit: The varying stages of maturity at which the apples were picked were held to be the cause. Under this heading size of fruit comes in, and also the difference between fruit gathered at the first picking as compared with that gathered at the later pickings.

Age of trees: It is widely accepted that the fruit from older trees stores better than that from younger trees. It was shown, however, that the fruit of certain growers stored well in 1919, whereas in 1920 their stored fruit failed. Thus the trees when a year younger gave better results.

Time elapsing between packing and delivery: In this matter there was little definite evidence available. I was dependent mainly upon the word of the grower. But if it is held that delayed delivery was the cause of the trouble, one has to assume that a number of successful growers who are thoroughly aware of the necessity of prompt delivery failed to carry this out in two successive years.

This by no means exhausts the evidence that was collected to show that none of the field conditions referred to were in themselves the cause of flesh-collapse. But I will now pass on to the experiences of several

growers who happened to have stored part of their fruit in one firm's cool store and part in that of another firm. There were several instances in which fruit stored perfectly in one store and developed flesh-collapse in another, and these examples are of immense value in showing that certain of the suspected field conditions were not in themselves capable of inducing the disease. If, for instance, an orchardist picks the fruit of a single variety in his orchard, that crop as it is picked has certainly experienced the same weather and soil conditions. The cultivation will have been the same, the age of the trees is the same, and it matters not how inefficient the pickers were; they were the same throughout, and the maturity will be similar throughout. Further, if that orchardist puts, say, 2¼ in. to 3¼ in. fruit in one store and the same size in another store, one would certainly expect such fruit to keep a similar time if the storage conditions were alike. In several cases, however, it was found that such apples stored well in one store but developed flesh-collapse in the other. The evidence went strongly to show that neither the weather, the cultivation, the maturity, the size of apple, nor the age of the tree was in itself the cause.

Now comes what may on the surface appear to be a contradiction of what has just been said. Despite the foregoing remarks, I firmly believe that apples as they reach the cool store differ markedly in their resistance to cool-storage conditions. My reasons are as follows:—

Regarding the susceptibility of apples to flesh-collapse—firstly, the flesh of one variety admittedly differs from that of another: Sturmers are well known to keep longer than Jonathans. Next there are differences in the fruit from different localities: the Sturmers from one locality developed no flesh-collapse, while those from another developed it abundantly even in the same store. Thirdly, there are differences among individual apples in the same package; some develop flesh-collapse and others do not. Lastly, in the same apple one side seems more susceptible than the other; the uncoloured side commonly showed more damage.

Actually this is not contradictory. The whole of these arguments are governed by the next statement: One would certainly regard the fruit from the orchardist who had experienced the most trouble with flesh-collapse as being the most susceptible, but despite this such susceptible fruit was affected in one store yet kept well in another. The conclusion I draw from this is as follows: One is bound to admit that the quality of the flesh of some varieties, lines, or individual apples as they reach the cool store is such as to render them more liable than others to flesh-collapse; but by no means can one admit that this inherent susceptibility in such apples is sufficient to prevent them from being satisfactorily cool-stored.

Cool-storage Conditions: Temperature.

We now arrive at a consideration of cool-storage conditions in connection with the investigation. It was very commonly held that flesh-collapse was brought about by freezing, the suggestion being that inadvertently or through negligence the temperature of a store was allowed to drop below 32° F., and thus result in injury. Firstly, flesh-collapse was found to occur in a number of stores, and it is somewhat unlikely that negligence in the matter of temperatures would be a common occurrence. This argument, however, is inconclusive, and can be dismissed. Secondly, it was decided to make a test of the effects

of varying temperatures upon apples. A number of Sturmers of different lines were placed in the duct of a cool room. The temperature of the duct was rapidly reduced from 50° to 20° F. The fruit was kept at this for six or seven hours, and was examined at intervals. Some of the fruit was then brought out into a temperature of 60° and allowed to warm up. The temperature of the duct was allowed to rise gradually overnight to about 40°, and next day was again subjected to 20° for some hours. The power was then turned off and the temperature again rose. The fruit was left in the duct for a week, when it was examined. No signs of flesh-collapse developed in any of the apples.

A number of attempts were made to artificially produce flesh-collapse by fluctuating temperatures and other means, but without success. It therefore seems unlikely that the dropping of the temperature for a short time would have sufficient effect to cause the trouble. I could find no quick means of producing this condition, and consequently began to think of effects that would be more gradual.

It is a significant fact that both in 1920 and 1921 flesh-collapse made its appearance about the same time—September. Thus for three or four months the fruit successfully withstood the storage conditions. After that flesh-collapse made its appearance. With this in mind, inquiries were made as to what temperatures were employed in different stores. The stores in general adopted the 32° standard. Later on, however, it was found that there was very great differences in the time during which different stores kept their machinery running. Some stores reduced their temperatures to 32° in the morning, ran for eight hours, then shut off and trusted to their insulation to maintain a sufficiently low temperature. Other stores were running much longer, even up to twenty-four hours in the day. Thus there is a very considerable difference in practice.

This brings me to the theory upon which I am working at present, which is as follows: The flesh of the apple cools more slowly and warms up more slowly than the atmosphere of the store. Hence the apple may be said to average out the varying temperature of the chamber. If one store is running twenty-four hours at 32°, while another is kept at that temperature for only eight hours, then it is certain that the average temperature of the apples in the eight-hour store will be higher than 32°. Prolonged exposure to a temperature of 32° might possibly exert some strain upon the flesh and consequent injury. (There are certain peculiar physical happenings to water at 32°.) In a few months this might possibly manifest itself in flesh-collapse. Certainly it seemed that those stores that were running for shorter hours had less flesh-collapse than others. On board ship, where it may be presumed the machinery is running for long periods, one certainly seems to find abundant flesh-collapse. This is, of course, only theory; but I have an experiment going to ascertain the effects of storing Sturmers at a slightly higher temperature—namely, 34° to 36°. I should like to try higher temperatures still, but this would entail either special apparatus or else some risk to a large quantity of fruit.

LINES OF INVESTIGATION.

In conclusion, I may say that in New Zealand we have practically no first-hand knowledge as to the best storage temperature for fruit, and one cannot say for certain that the temperatures used in other

countries will suit our apples. There are therefore two lines of investigation that suggest themselves to me as important: Firstly, the investigation of the optimum temperatures for the storage of New Zealand apples; and, secondly, the means by which certain New Zealand apples can be rendered more resistant to cool-storage conditions.

TESTING OF PUREBRED DAIRY COWS.

CERTIFICATE-OF-RECORD LIST FOR THE HALF-YEAR.

W. M. SINGLETON, Director of the Dairy Division.

THE appended lists contain the records of those cows which have received certificates during the half-year ended 30th June, 1922. The list is small, for the reason that few cows complete their test during the first six months of the year.

Several very creditable performances are recorded. In the Jerseys the outstanding yields are those of the two mature animals, Sylvian Prim and Signal's Lioness. These are half-sisters. Sylvian Prim, who has a record of 747·06 lb. fat, was bred by Mr. John Hale, New Plymouth, and was tested by Mr. W. Pollock, of Stratford. Her sire is Soumise Tom, sire of seven C.O.R. daughters, including Lady Superior, with 680·33 lb. fat. Soumise Tom is by Soumise Majesty, sire of nine C.O.R. daughters. The dam of Sylvian Prim is Primrose XXVIII, who traces back to such well-known males as Monopoly, Garibaldi, and Peter, and on the female side through the Mulberry and Primrose strains. Signal's Lioness, with a butterfat credit of 726·38 lb., is by Soumise Tom from Signal Queen. Signal Queen's pedigree contains the name of St. Brelade (sire of Madam Mayflower, for several years the Dominion's Champion Jersey), Viper, and Sailor Boy. Students of the breed will recognize names which have had a lasting influence on it in New Zealand.

In the Friesians Ellesmere Eileen is deserving of mention. Commencing her test at the age of 2 years 59 days, she produced in 365 days the fine credit of 651·11 lb. fat from 20,480·45 lb. milk. She was bred by Mr. T. H. Overton, Lakeside, Canterbury, and was tested by Mr. L. R. Stoddart, Willowby, Canterbury. She is by Mutual Mercedes Pietertje (a son of Mutual Pearl of Rock, with a C.O.R. for 903·44 lb. fat), who is sire of five C.O.R. daughters, including Friens Mercedes Aquila, who, commencing her season at the age of 1 year 295 days, produced 514·98 lb. fat. The sire of Mutual Mercedes Pietertje is Mutual Piebe of Rock, sire of eight C.O.R. daughters, and Mutual Piebe of Rock is by Mutual Piebe de Kol, sire of nine C.O.R. daughters, including Mutual Pearl of Rock. The dam of Ellesmere Eileen is Longbeach Butterfly, who is by Kruger II, sire of thirteen C.O.R. daughters. It will therefore be seen that this heifer is the offspring of several generations of proven ancestry.

An Ayrshire deserving of mention is Milkmaid of Springview (Mr. A. H. Hansen, of Te Rehunga) who has produced 510·34 lb. fat, commencing test at the age of 7 years 57 days. This cow was on test the preceding season, when she produced 600·21 lb. fat from 12,826·2 lb. milk, which record makes her the premier Ayrshire cow of New Zealand.

RECORDS FROM 1ST JANUARY TO 30TH JUNE, 1922.

Name of Cow, and Class.	Tested by	Age at starting Test.	Fat req'd. for Cert.	Yield for Season.		
				Days.	Milk.	Fat.
		JERSEYS.				
Junior Two-year-old.		Yrs. dys.	lb.		lb.	lb.
Kaucket's Princess ..	G. R. Bell, Waipuku ..	2 49	245·4	365	10,359·75	563·19
Bachelor's Fairy Queen	W. J. Anderson, Levin	2 12	241·7	365	7,572·20	504·07
Silverdale Prim ..	G. Hodgson, Whakapara	1 278	240·5	365	8,130·05	451·88
Holly Oak's Beauty..	J. Hale, New Plymouth	1 134	240·5	365	7,135·50	440·46
Charm's Marigold ..	G. Buchanan, Paeroa	2 22	242·7	365	7,649·70	383·98
Waireka's Maid ..	E. R. Bayly, Omata ..	1 248	240·5	248	6,833·20	316·94
Clyde Vale Letta's Petunia	H. R. Manring, Maharahara	1 328	240·5	289	5,802·10	305·34
Willow Bank Wonder Girl	F. Ranford, Stratford	2 5	241·0	274	5,766·20	281·76
Jersey Park's Joyful	T. Kendall, Whenuakura	2 5	241·0	186	5,062·60	280·46
Burford Countess Sultane	R. Chilcott, Frankton Junction	1 286	240·5	298	4,855·20	279·59
Illawarra's Lass ..	M. G. Maxwell, Opunake	1 341	240·5	211	4,737·05	261·65
Lady Starbright ..	J. F. Shepherd, Opunake	1 361	240·5	222	4,632·00	260·05
Senior Two-year-old.						
Signal's Wave ..	A. R. Buckman, Piopio	2 167	257·2	295	9,145·50	523·01
La Serena	F. J. Saxby, Hamilton	2 119	252·4	365	8,926·20	497·33
Silverstream Lady Fox	G. B. Hull, Silverstream	2 273	267·8	353	7,907·10	403·87
Pretty Primrose ..	A. Buchanan, Palmerston North	2 359	275·9	352	7,568·50	363·26
Asterina	J. Kelso, Tamahere ..	2 155	256·0	306	5,307·70	287·76
Three-year-old.						
Laureate	J. Hale, New Plymouth	3 275	304·5	365	11,156·30	596·95
Silverdale Maid ..	G. Hodgson, Whakapara	3 247	301·7	292	8,442·20	425·40
Hillsbourne Clarisse..	A. Buchanan, Palmerston North	3 288	305·8	327	6,207·20	340·43
Viola's Golden Mercedes	E. Griffiths, New Plymouth	3 62	283·2	210	5,101·50	312·49
Four-year-old.						
Tahua Mary ..	S. Atkinson, Papatoetoe	4 116	325·1	365	8,218·90	560·09
Mature.						
Sylvian Prim ..	W. Pollock, Stratford	6 164	350·0	365	13,790·50	747·06
Signal's Lioness ..	J. Hale, New Plymouth	5 54	350·0	365	12,882·20	726·38
Te Mara's Cosette ..	H. P. Toose, Feilding	7 136	350·0	360	10,743·90	646·63
Yellow Ixia ..	C. A. Care, Cambridge	5 46	350·0	365	11,858·10	615·41
Darkie's Pet ..	J. Hale, New Plymouth	5 267	350·0	365	9,418·10	585·06
Moiraleen	G. Hodgson, Whakapara	7 286	350·0	347	9,519·05	541·17
Dolly of O.K. ..	J. Magill, Normanby	5 139	350·0	365	9,513·70	516·28
Sultan's Lass ..	J. Penny, Mangatoki	9 64	350·0	340	8,895·00	492·26
Victoria's Farewell ..	P. J. Linn, Normanby	8 65	350·0	321	10,040·10	449·76
Dorothy Violet ..	G. Hodgson, Whakapara	6 340	350·0	305	7,145·90	441·93
Sweet Mermaid ..	F. J. Saxby, Hamilton	9 238	350·0	346	7,373·30	386·07
Etiquette	W. H. Booth, Carterton	5 196	350·0	293	7,761·80	379·63

LIST OF RECORDS—*continued.*

Name of Cow and Class.	Tested by	Age at starting Test.	Fat req'd. for Cert.	Yield for Season.		
				Days.	Milk.	Fat.
		FRIESIANS.				
Junior Two-year-old.		Yrs.dys.	lb.		lb.	lb.
Ellesmere Eileen ..	L. R. Stoddart, Wilowby	2 59	246·4	365	20,480·45	651·11
Brookdale Johanna Canterbury	S. Knight and Sons, Ongarue	1 162	240·5	365	11,750·00	470·08
Rosevale May Abbekerk	H. North and Sons, Omimi	2 17	242·2	365	12,742·50	427·66
Cluny Pietje Edinglassie IV	Cluny Friesian Farm, Upper Hutt	2 20	242·5	290	12,109·00	423·06
Brentwood Johanna Beauty	Bloomfield Farm, Upper Hutt	2 44	244·9	365	10,026·60	378·25
Junior Three-year-old.						
Rosevale Nancy Posch	H. North and Sons, Omimi	3 69	283·9	365	19,651·10	591·51
Mutual Fannie Vale Pietertje	W. Barton, Featherston	3 98	286·8	365	16,401·30	587·94
Rosevale Holland Pet	H. North and Sons, Omimi	3 37	280·7	365	16,673·10	506·44
Senior Three-year-old.						
Rosevale Sylvia Keyes	H. North and Sons, Omimi	3 306	307·6	365	21,548·60	625·73
Rosevale Burkeyje Sylvia	H. North and Sons, Omimi	3 240	301·0	365	15,125·40	617·46
Junior Four-year-old.						
Rosevale Rosie Posch	H. North and Sons, Omimi	4 113	324·8	365	16,109·60	600·79
Mature.						
Lakeside Canary Indi	H. R. Green, Kairanga	6 363	350·0	365	20,594·50	623·30
	SHORTHORNS.					
Mature.						
Studleigh Camelia ..	D. Buick, Palmerston North	5 335	350·0	365	10,488·00	442·30
	AYRSHIRES.					
Three-year-old.						
Fairy Bell of Riverside	A. H. Hansen, Te Rehunga	3 56	282·6	365	10,016·60	417·26
Mature.						
Milkmaid of Springview	A. H. Hansen, Te Rehunga	7 57	350·0	365	10,923·30	510·34
	Second-class Certificates.					
	JERSEYS.					
Junior Two-year-old.						
Jerseydale Crystal ..	J. Pettigrew, Pihama	2 49	245·4	365	8,065·40	412·49
Veronica	S. R. Lancaster, Palmerston North	6 59	350·0	356	8,033·75	463·10
	FRIESIANS.					
Mature.						
Lady Johanna Piebe de Kol	H. R. Green, Kairanga	8 306	350·0	365	22,171·75	623·01

STERILIZATION OF SOIL IN GLASSHOUSES.

OPERATIONS WITH STEAM PLANT AT NELSON.

Horticulture Division.

THE cultivation of tomatoes, both under glass and in the open ground, is attended by a good deal of risk of losses caused by insect and fungus pests. To how great an extent these troubles are due to mistakes on the part of growers no one can say, but it is practically certain that this is a factor to be reckoned with. Some years ago losses in under-glass tomatoes were very great, the trouble extending through practically the whole of the Dominion. The Horticulture Division was called upon to investigate the trouble, and in 1913 experiments were carried out in a number of houses lent for the purpose. From observations made the opinion was formed that a too liberal use of organic manures and artificial fertilizers and the maintenance of over-humid conditions of atmosphere were the chief causes of trouble; further, that lack of necessary spraying was responsible for preventable losses. The experimental work carried out proved these deductions to be correct, and the propaganda carried out by the Division at that time certainly had good results, wholesale losses now being very rare. There is, however, still a good deal of trouble with various blights that affect tomatoes and cucumbers, and very considerable losses from eelworm, which affects both plants.

Experimental work in soil-sterilization has been carried out for a good many years in England, America, and other countries, and in recent years in New Zealand. About six or eight years ago in England an apparatus named the "Fumo" was invented for sterilizing the soil by steam for the destruction of the spores of fungi which attack plants by means of the root, such as *Fusarium lycopersici* (sleeping-disease), *Plasmodiophora brassicae* (club-root), and also the resting spores of mildew, *Cladosporium fulvum* (leaf-mould), rust, blights, and other fungi which attack the foliage of tomatoes, cucumbers, &c. The high temperature of the steam, above 212° F. (boiling-point), also effectually destroys wireworms, grubs, and other insect pests which gnaw at the roots of plants. The absence of weeds growing in sterilized soil is very noticeable, showing that the great heat of the steam kills weeds and weed-seeds. It has also been found that the application of steam to soil has the effect of rendering some of the soil constituents more soluble, so that tomatoes and other plants thrive in a remarkable manner, and the general result is equal to manuring the soil, while plants growing in sterilized soil remain in a healthy condition.

The patent "Fumo" apparatus consists of a frame constructed of steam-pipes in the form of a harrow or grid, with prongs or teeth about 10 in. in length, which are also hollow. The teeth are pointed, and perforated to allow the steam to pass through into the soil. The parts described are all covered with a light metal cover, which effectually prevents a waste of steam from passing out of the soil. The apparatus

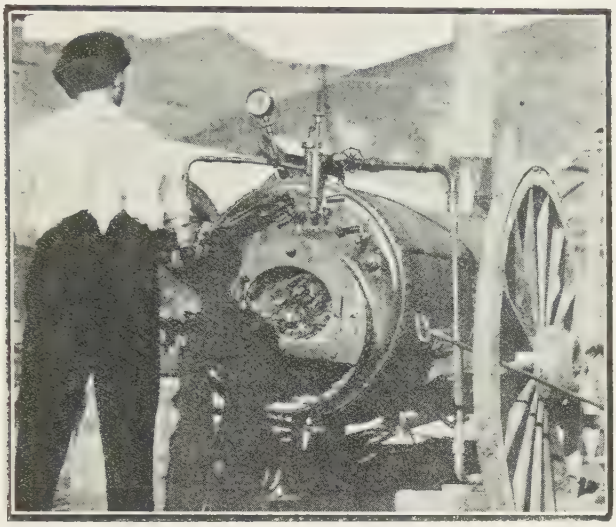


FIG. 1. THE 6 H.P. BOILER USED WITH MESSRS. VITETTA BROS.' STEAM SOIL-STERILIZING PLANT AT NELSON.

The four following illustrations also relate to this plant.

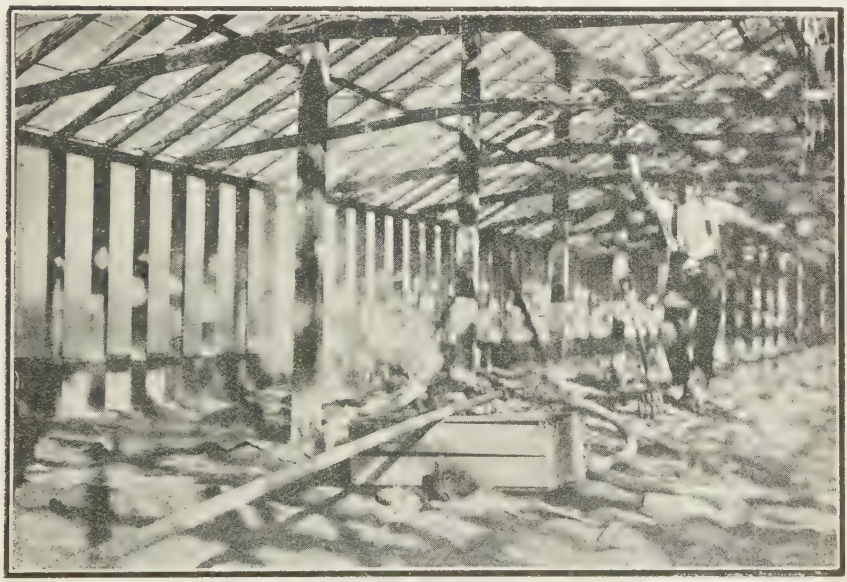


FIG. 2. SHOWING HOW THE STEAM IS TAKEN INTO A TOMATO-HOUSE.

The steam is taken in galvanized-iron piping through a two-way connection and rubber hose to the two steam plates or harrows.

may be of any required size. A portable steam boiler or generator is placed at any convenient distance near the glasshouse, and this is connected with the sterilizer by steam-pipes and a flexible tube.

The method of using the apparatus is as follows: After the soil has been loosened by forking over, the prongs of the harrow are thrust into the soil by pressing the apparatus downwards—generally by the weight of a man's foot; steam is then turned on at the boiler, when pressure is at from 40 lb. to 50 lb. to the square inch, and instantly the steam impinges on every part of the soil covered by the sterilizer. In this form a hundred jets of steam pass through the perforations in the prongs in such an effectual manner that the soil is steamed to a depth of 9 in. at least in about two to three minutes, according to the size and power of the steam-generator. The portion of the soil covered by the sterilizer is saturated by steam, the whole being brought to a temperature above boiling-point. Steam is then turned off at the generator, while the sterilizer is removed to a fresh place, this taking about two minutes to accomplish. Pressure of steam is then turned on again at the steam boiler and applied as before.

The sterilizing-apparatus may be of any size, but the usual size, convenient for one man to work and lift about, is 5 ft. by $2\frac{1}{2}$ ft. or its equivalent. In this way a portion of soil slightly larger than the apparatus is sterilized at each shift. About 1,800 square feet of soil is usually sterilized in a day with one apparatus, at a cost of about 10s. for fuel and labour per 1,000 square feet (this is under English conditions); but if the steam-generator is sufficiently powerful two or more sets of apparatus may be worked simultaneously from the same generator. This form of sterilizer is more economical to use than any other, because the soil has not to be removed and replaced, as is the case with other appliances used for steam sterilization.

It is evident that the high temperature of the steam will destroy the soil bacteria within its action. It is well known, however, that these organisms are more abundant below the top 9 in. of soil, and the latter appears to become quickly reinoculated from the subsoil. If this was not the case the fertility of the soil would, of course, be injuriously affected. Experience has shown that sterilized soil is sweet and devoid of acidity.

A fairly full description of this method of treating soil, together with a tracing of the apparatus, was supplied by the Horticulture Division to inquirers in 1918. At Nelson Messrs. Vitetta Bros. have brought the method into practical use, as the following report from the Orchard Instructor, Mr. W. C. Hyde, will show. The accompanying illustrations are from photographs of the apparatus used by Vitetta Bros. Mr. Hyde states:—

"Of very great interest is the work now being done here by the Vitetta Bros. They are busy carrying out contracts to steam-sterilize the soil in about three dozen tomato-houses in Nelson City. In many cases the potting-soil is receiving similar attention. This indicates the opinion of the best growers here regarding the matter. The plant has been considerably enlarged. A horizontal 6 h.p. boiler is used, working at a pressure of 75 lb. of steam. Two harrows are used—a 2 ft. 8 in. by 2 ft. 8 in. and a 4 ft. by 2 ft. 8 in. The small one is found useful for working out the corners. These keep two young

FIG. 3. THE LARGER HARROW TURNED UP TO SHOW THE TINES.

These tines are of galvanized piping perforated in seven places for the emission of steam. There are sixty-three on a plate 4 ft. by 2 ft. 8 in.

FIG. 4. BRINGING THE HARROW INTO OPERATION BY PRESSING THE TINES INTO THE GROUND WITH STEAM ON.

fellows busy manipulating them all day, while one of the Vitetta Bros. is attending to the boiler and general supervision. A glasshouse 75 ft. long and 25 ft. wide is a good day's work. The steam-plates (harrow is a very good descriptive term) are pressed into the ground, and after about five minutes' saturation indicates that the steam has done its work. The plates are then lifted and moved to the next section, the treated area being covered with sacks. Tests showed a consistent temperature of 212° F."

It is too early as yet to say what degree of benefit this steaming process will be, but there is no reason to doubt that it will be considerable. It will not, however, be safe for growers to become lax in other ways, for steaming the soil cannot give permanent immunity. The amount of good it will do in cases of eelworm

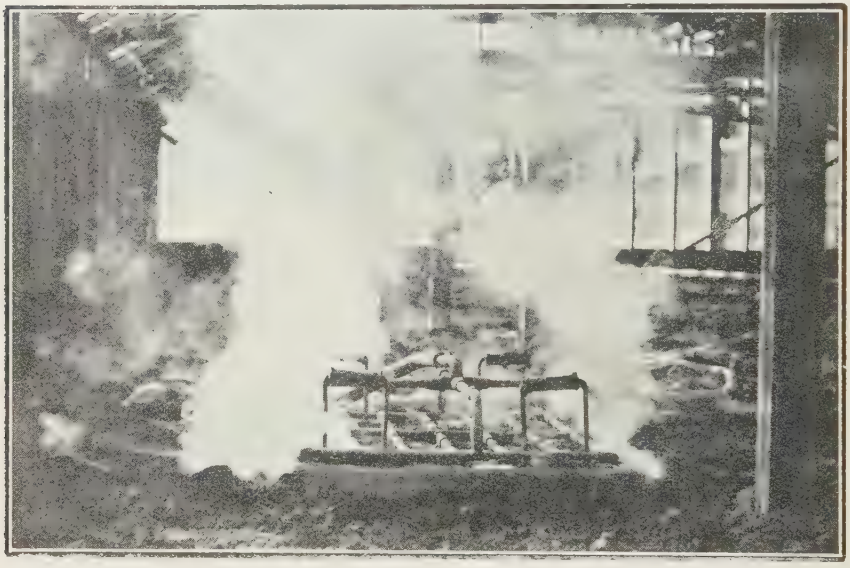


FIG. 5. SHOWING THE SOIL-COOKING PROCESS COMPLETE.

Cooking takes about five minutes, and is complete when saturation is visible and steam escaping. This figure shows the smaller of the two harrows.

infection is also problematical. Tests have shown that the apparatus heats the soil to 212° to a depth of 9 in. How far sufficient heat to kill eelworms extends below that depth we do not know. We do know that eelworms are found as deep as the depth penetrated by roots of the plants, and that in many cases is more than twice 9 in. We also know that if the subsoil remains infested the top soil will speedily be reinforced. In most of the experiments of which we have records disinfection for eelworm has been done with chemical substances. An account of experiments of this kind carried out for us, the Horticulture Division, by Mr. C. W. Howard, of Lower Hutt, appeared in the *Journal* for October last.

FEED-BOX FOR WALK-THROUGH MILKING-SHEDS.

J. L. BRUCE, Superintendent of Experimental Farms, Wellington.

In last month's *Journal* drawings were given of a disappearing feed-box designed to meet the requirements of dairymen with walk-through milking-sheds. Perhaps the only objection to the popular walk-through shed has been the difficulty of feeding concentrated food to the cows when in the stalls. This simple device should therefore be largely taken advantage of. It pays handsomely to provide dairy cows at certain seasons of the year with a liberal supply of concentrated foods.

FIG. 1. SHOWING ARRANGEMENT OF THE FEED-BOX AND STALL.

Note the battens fixed forward in recess.

These boxes, which were installed at the Pukeora Sanatorium Farm last month, have proved in every respect satisfactory. One or two little improvements on the details shown last month have suggested themselves. By removing the three battens on the front of the recess and fixing them forward about 30 in. the double purpose is gained of more easily replenishing the feed-boxes and of handling the cow-covers. With this slight alteration it has been found that the feed-boxes can be conveniently turned forward by hand after replenishing the food—that is, without using the draw-pole. The withdrawal of the box into the recess without using a

draw-pole can also be done equally well by attaching a cord to the screw-ring, passing the cord through a staple or small pulley affixed to the wall, and fastening the end to the upright of the recess, when it can be conveniently pulled for the removal of the box before opening the exit-door. This method is recommended.

FIG. 2. FRONT VIEW OF BOX, TAKEN FROM OUTSIDE THE SHED (DOOR OPEN).

The box is firmly screwed to the door-stud about 1 ft. above the floor-level and about $\frac{1}{4}$ in. above the 4 in. by 2 in. lower batten, so that the underneath stop will keep the trough in position while the cow is feeding, or in the event of rough usage it will rest temporarily on the batten, thus relieving the hinges of undue pressure.

It is estimated that these boxes can be manufactured in wholesale lots at about 16s. each.

The cows shown in the accompanying photos certainly give the impression of contentment—enjoying their ration of concentrated food, and at the same time responding freely to the pulsation of the milking-machine.

FIG. 3. GENERAL VIEW IN THE WALK-THROUGH MILKING-SHED AT THE HEALTH DEPARTMENT'S PUKEORA SANATORIUM FARM.

One of the feed-boxes may be seen on the extreme right. The two other photos were also taken in this shed.

CARE OF MILK ON THE FARM.

A. A. McKENZIE, Dairy Instructor, Palmerston North.

CARE of milk on the farm is a matter of vital importance to the dairy industry. Almost all the defects in our cheese and butter are directly due to the lack of proper care of the raw material during and after milking.

One of the chief sources of trouble is found in unclean milking-machines. Complete instructions for their cleaning were recently issued by the Director of the Dairy Division, but a few special points may be dealt with here. It is a common belief that boiling is detrimental to the rubbers: this is not so—weekly boiling lengthens their life. Exhaustive tests have proved conclusively that it is an impossibility to keep milking-machines clean without boiling. Experiments have also proved that chemicals such as chloride of lime, &c., are of no use in so far as reducing bacteria is concerned.

In connection with the cleaning of milking-machines, I have often found the milk system clean and the vacuum neglected. On pointing this out to many dairymen it is found they had been of opinion that a foul vacuum system did not make its presence felt. This is not the case, and scores of instances could be given where the cause of unsound milk from certain farms was traced to the vacuum system. After a thorough system of cleaning was adopted all trouble disappeared.

Slimy milk, the bugbear of cheesemakers, has been traced to machines that were in bad condition, and any cheese-factory that has one or two slimy vats per week is losing more than one man's wages, as the consequent yield of cheese is materially reduced.

Many cans of milk that would otherwise be of good quality are badly contaminated by absorbing the smell of the shed and yard during the night. This is brought about by having the milk-stand on the sheltered end of the shed, which allows the prevailing wind to carry the objectionable smell direct to the milk. In many cases the milk-stand is practically within the yard. Milk-stands should be erected on the windward end of the shed, and well away from any yard smell. Where the yard is so constructed that it surrounds the shed there is only one remedy—namely, to place the milk-cans containing the milk on the cart and draw it out to clean surroundings. In instances where tried this procedure has immediately overcome the trouble. Any dairy-farmer can prove this for himself by leaving an open sample of milk in or about the yard overnight, setting another sample of the same milk in a wholesome atmosphere well away from any yard or other smell, and comparing the two lots in the morning. Both utensils must, of course, be equally clean beforehand.

A common practice is to have the evening's milk held overnight in cans almost full. The supplier who does so is courting trouble. With such a large quantity of milk it takes considerably longer to get rid of the animal-heat, and as germ-life thrives to a greater degree in milk of such temperature it naturally follows that it is sound sense to assist cooling as quickly as possible. Where it is possible to have a water cooler installed, this is advisable. The dairyman will soon

repay himself for the outlay and save himself many anxious hours on a stuffy warm night. At many farms, however, there is no available water-supply for cooling. In such cases the evening's milk should be spread into all the available cans. It must also be remembered that the cream rises quickly, forming a fatty cover over the top, through which the animal-heat escapes but slowly. If the milk is well plunged with a metal plunger two or three times at intervals during the evening this will be found of great assistance in eliminating strong-flavoured and overripe milk. The use of a wooden batten for this purpose is most harmful. The wood in time becomes saturated with milk, and when scraped gives off a yellow slime similar to and producing the same effect as that found in unclean machines, buckets, and milk-cans. As this yellow substance is teeming with germ-life it naturally follows that every care is necessary to keep it in check.

Many instances have come under my notice where the evening's milk has been severely dealt with by exposure to the morning sun. Only a small outlay of labour and cash is required to erect a shade. It is not suggested that a milk-house be erected—merely a roof and one wall, or one high wall only, depending on the position of the stand.

A feature most noticeable on the receiving-stage at any of our factories is the number of suppliers who mix warm and cold milk. This not only causes a loss to the supplier by loosening a fair portion of fat, which will be found floating on top in pellets and clusters, but also causes in many cases a higher acidity in the evening's milk, to the detriment of the article. Owing to such mixing it has been found necessary to reject milk which would have been quite acceptable otherwise.

Having reached the stage of delivery to the factory, a few hints on the care of the cans may be of value. The most general practice is to fill up the empty cans with whey or skim-milk. While this is bad practice, it may be unavoidable in most cases. These cans, however, should be emptied immediately on returning to the farm, well scrubbed with hot water and soda, then rinsed with boiling water and left standing in the sun, tops up, and open, or lying on the side, so that any available sunlight may have full effect. Cans that have had whey left standing in them for some time are exceedingly difficult to clean: the penetrating acid in the whey enters the metal, and, being persistent in action, is hard to remove. Warm milk placed in whey-logged cans and held overnight is tainted, gassy, and often overripe when delivered to the factory next morning. Suppliers have no doubt often noticed a soured coating of milk adhering to the bottom of the can after tipping the milk. I have found this common trouble to immediately disappear after a thorough washing and scalding system has been adopted. This souring, of course, only occurs in extreme cases, and many cans deliver whey-tainted milk which can only be detected by the flavour. Cheese manufactured from such milk is not of good flavour, and owing to the presence of gas is inclined to openness.

Milk-buckets should be treated to the same cleaning and sunlight as the cans. Any kerosene or benzine tins which are in use as milk-buckets should be carefully gathered and, after having the bottoms kicked out, dropped into a deep gully. Cloths used with the idea

of cleaning milk utensils should accompany them. Kerosene-tins, not being intended for milk-pails, are not soldered round the inside seam, which is simply turned, and they are almost impossible to clean. A cloth at best is only a harbour for germs, and a poor kind of scrubber at any time. A good scrubbing-brush will stand a lot of weight when in use, and can afterwards be placed in the sun to sweeten.

The use of a cloth as a milk-strainer is very often the cause of faulty milk. It is much more sanitary to have a proper gauze strainer; the gauze can be easily cleaned and cheaply replaced when worn. Strainer-cloths in a short time become yellow, and all milk passed through becomes well impregnated.

When washing up any milking-utensils or whey-cans the milk-stand should on no account be used as a wash-up bench. All around the milk-stand must be sweet and dry.

WORK FOR THE COMING MONTH.

THE ORCHARD.

At the annual conference of the New Zealand Fruitgrowers' Federation, held last month, a number of important matters concerning the industry came up for discussion, chief among which were the subjects of standardization of fruit for local markets, standardization of fruit-cases, and export matters. As a full report of the conference is published in the official organ of the Federation, only brief reference need be made here to some of the principal items. The matters relating to export were referred to a special export committee set up at the conference to deal with them in collaboration with officers of the Department of Agriculture at a meeting to be arranged. This meeting is to take place during the present month, and the decisions of the committee will be available at a later date.

The Department was urged at the conference to enforce the use of the standard fruit-cases prescribed in the present regulations. The question of making compulsory the packing of fruit to recognized standard grades was given a good deal of consideration by the conference, it being realized that no system of improving present market conditions could be satisfactorily put into operation unless something was done in this direction. This matter was also referred to a special committee to draw up proposed standard grades and submit their recommendations to the Federation executive at a later date.

—*W. T. Goodwin, Assistant Director of the Horticulture Division.*

AUCKLAND.

Every opportunity should be taken to push on with the pruning of both stone-fruit and pip-fruit trees, which work, however, should now be well forward. As soon as each block of the orchard is finished all prunings should be at once gathered up and destroyed by burning. These remarks apply more especially to the pruning of pip-fruits, as there is here a danger of carrying over fireblight and other disease infection from one season to another through neglecting to destroy by burning all such prunings throughout the orchard.

As soon as the sap begins to rise, the regrafting of pip-fruit trees may be carried out where required.

Where weather and soil conditions are suitable, the planting-out of new areas or the filling-up of spaces from which dead trees have been removed may now be taken in hand. The month of August is also an opportune time to plant out young citrus-trees, as at this late date there is a minimum of risk of injury by frosts.

Owing to the several heavy frosts experienced in Auckland this winter a large number of citrus groves have been rather severely cut back, and in consequence it is necessary to pay careful attention to the cutting-away of all such injured wood as soon as the full extent of the damage is apparent. When cuts are made the greatest care should be exercised in cutting to an outward bud in each case, and also to avoid leaving snags, thus preventing the entry of borer.

Strawberry-growers are advised to keep their beds well worked throughout the early and late spring months, in order to ensure a maximum of growth.

Fireblight: Growers are again warned to keep an ever-watchful eye for hold-over cankers on pip-fruit trees. Immediately any such cankers are identified they should be treated as directed in last month's notes. Fruitgrowers, more especially those in the commercial areas, who still have hawthorn growing on their properties are again advised to deal with this plant by grubbing it completely out by the roots and destroying the refuse by burning. There are still a number of orchardists in areas where hawthorn has been declared a noxious weed by the local body and who yet have this plant growing on their properties. These are required by the Noxious Weeds Act to again cut back hedges during the coming spring; but, quite apart from the statutory requirements, the only effectual means of dealing with the hawthorn from the fireblight point of view is to entirely grub the plant out, and this course is earnestly recommended.

—J. W. Collard, Orchard Instructor, Auckland.

HAWKE'S BAY.

Planting: Planting should be completed as early as possible consistent with proper soil conditions. Choose a time when the soil works freely.

Pruning: Pruning of all classes of fruit-trees should be pushed on with all possible speed. Carefully gather and destroy all prunings, and mark diseased or weak trees for special treatment.

Cultivation: Spring ploughing should be done as soon as opportunity offers, turning under cover all weeds to facilitate early decay. It is very desirable to have this work finished before trees become active, as large numbers of spores are to be found on fallen leaves, small prunings, &c., and are readily liberated if the refuse is left on the surface of the land. If the refuse is turned under the risk is considerably less, as the spores become less viable with the decay of the vegetable matter.

Spraying: Delayed dormant spraying will need attention. Almonds and apricots show early bud-movements, followed by peach, plum, and nectarine. Stone-fruit trees infected with scale insects should receive an application of lime-sulphur, 1-15, about two weeks prior to bud-movement. When the majority of the buds show pink they should receive an application of bordeaux, 8-6-40, as a safeguard against fungoid diseases.

—W. H. Rice, Orchard Instructor, Hastings.

NELSON.

The pruning of stone-fruit trees and also of pear and apple trees should now be completed. Finish the pruning season by giving attention to orange and lemon trees about the end of August. It is a common misapprehension that these evergreens do not need pruning; but if, at the season mentioned, growth is thinned and the framework of the tree is well spaced out the value of pruning will be amply demonstrated.

Tree-planting, too, is an operation which should now be brought to a conclusion. Plant when the soil is reasonably dry; plant at the right depth; and plant as firmly as possible. The last point is the one most commonly overlooked.

Some of the lighter sections will be ready for ploughing during August. Give the job every consideration, and do it neatly. This is a good opportunity for applying lime or manures; drill in or broadcast these over the whole area, and follow the application with a stroke of the harrows. It is unreasonable to expect to gather heavy crops year after year, especially of stone-fruit, without putting anything back. Experience has proved that the cropping-power of trees is prolonged—indefinitely in most cases—where this attention is given.

Brown-rot and shot-hole, fungi that have levied such a heavy toll on the stone-fruit crops in the past, were practically non-existent in some of our best orchards last season. There can be little doubt that this was due to careful spraying and general cleanliness. The practice has been to apply bordeaux at winter strength shortly before the buds begin to move. As aphis and red mite

are big factors in this problem, the bordeaux is followed by an application of red oil where necessary. A further application of bordeaux is made three weeks or so later as the blossoms begin to break. Results depend largely on covering the whole of the tree with the protective spray. Other fungicides are good, but the foregoing treatment at this season has here given results that are conspicuously the best.

Continue to give the fruit-store careful attention. Those stores that are tightly built should be well ventilated on cold nights and kept close during the day. Do not let waste fruit lie about—feed it to the stock promptly.

—W. C. Hyde, Orchard Instructor, Nelson.

CANTERBURY.

All pruning operations should be carried on as expeditiously as possible, and all prunings gathered and burnt. If allowed to remain scattered or in heaps in or near the orchard they may easily become a source of infection during the spring.

If not already done, take the first opportunity of giving the spray-pump a thorough overhaul. A great deal of unnecessary delay is thus very often prevented, when perhaps each hour counts and spraying is urgent. It will be necessary to commence spraying operations on stone-fruit trees early in August for the control of fungus diseases, such as leaf-curl, bladder-plum, shot-hole, &c., using bordeaux, 8-6-40, just as the buds are swelling.

Where planting of young trees is contemplated, the land, if already ploughed, should be thoroughly worked, ready to receive a final cultivation before planting. A thorough preparation of the soil before planting is essential if the best results are to be obtained. When planting young trees take care to tread the soil firmly around the roots; they will then obtain a good firm set in the soil when they commence to grow. The best time to plant in this district is usually during the month of August. Where cover-crops have been grown they should be turned in as soon as they have made sufficient growth. Any other cultivation is quite unnecessary until the spring advances.

A watch should be kept on all fruit held for late marketing, whether in cool store or otherwise. If prices are fairly good no time should be lost in placing them on the market. Much good fruit may be easily lost by endeavouring to keep it beyond its normal period in the hope of obtaining still higher prices.

—L. Paynter, Orchard Instructor, Christchurch.

OTAGO.

August will see pruning operations well in hand and spray-pumps in operation. Before starting the work of spraying see that the pump and hoses, &c., are in good condition, and also cleanse the barrel well with hot water, soap, and caustic soda. Failures to get a good oil mixture are sometimes due to lack of cleanliness in this respect.

Stone-fruit trees will require spraying with bordeaux for peach-curl, shot-hole fungus, and bladder-plum immediately buds commence to swell. Apply at the strength of 8-6-40.

—B. G. Goodwin, Orchard Instructor, Dunedin.

VITICULTURE.

J. C. WOODFIN, Vine and Wine Instructor.

VINEYARD AND CELLAR.

PRUNING and ploughing should be continued in the vineyard as directed in last month's notes, burning all cuttings that are not required for scions. The pruning should be terminated as early as possible in all but the areas where there is any risk from late frosts. In these areas pruning should be performed as late as possible, but before the buds begin to swell.

Ploughing is frequently left until the pruning is finished, and this is sometimes late in the winter. It is preferable to plough in the beginning of the winter, and so expose the soil to the beneficial effects of the atmosphere—particularly to the pulverizing effects of the frosts—over as long a period as possible. The soil can be ploughed out from the vines, leaving a furrow along the vines where the pruners can stand when doing their work. In countries where severe frosts are the rule it is the custom to plough in to the vines in the

winter, and so cover the roots near the stocks with as much earth as possible to prevent their being frozen. No such precautions are necessary in New Zealand.

In the cellar, bottle as much wine as possible while the cold weather continues.

THE VINEHOUSE.

The vines in cool houses should be kept hanging down till the buds break on the lower part of the rods. To promote the rising of the sap the house should be kept closed at night and the top ventilators opened for an hour or two at midday. In suspending the rods wire hooks, made by bending pieces of fencing-wire, are preferable to binder-twine or other similar materials, which form a hiding-place for mealy bugs. For the treatment of young vines see the article "Vine-culture under Glass" in last month's *Journal*.

POULTRY-KEEPING.

F. C. BROWN, Chief Poultry Instructor.

AUGUST and September are the two principal months for hatching out chickens for the renewal of stock, and therefore constitute a period of considerable importance in the poultry calendar. Chickens brought out after September, or early in October at the latest, usually prove disappointing. I would therefore urge breeders to make every possible effort to secure the required number of chickens during the period named. To succeed in artificial chick-production the first great essential is to know that the parent birds possess constitutional vigour. Next in importance is to ensure that they are fed and managed in such a way as to promote the production of eggs containing strong germs. Many poultrymen consider that the incubation and brooding stages are the main considerations, but these are only necessary links in the chain of management. It is safe to say that the best incubator or brooder ever built will not give the desired results if the eggs in the first place are produced from weak or improperly fed stock. In the May number of the *Journal* some advice was given in regard to the care and management of the breeding-birds, and too much importance cannot be attached to this phase of the work. Strong chicks imply strong germs, and strong germs come only from healthy, vigorous breeding-stock. Given eggs containing the desired strength of germ, and with the up-to-date incubators now available, together with the increased knowledge as to their working, the matter of securing at least a fair hatch is generally assured.

INCUBATING POINTS.

Owing to there being so many different makes of incubators on the market, with varied systems of working, it is impossible to lay down any one general set of rules which could be applied to all machines alike. Thus the novice would be well advised to try no experiments, but to follow closely the instructions given by the maker for working his own particular machines. Of course, even with the most popular makes of incubators it is necessary at times to depart from the makers' instructions in order to suit special local conditions. Only after gaining some experience as a result of study and observation, however, is it a wise course to depart from the instructions laid down. There are some rules, needless to say, which apply to practically any class of incubator, such as the maintenance of an even temperature at about 102° F. for the first week, 103° for the second, and 104° when hatching. The correct degree of heat required means the temperature required by the germ which floats uppermost as the eggs lie on the tray. Thus the bulb of the thermometer should lie close between the tops of the eggs if the right degree of heat is to be recorded. As a general rule, if the eggs commence to pip on the twentieth day, and if the hatch is cleared up on the twenty-first day, it may be taken for granted that the proper degree of temperature has been maintained, and usually really good hatches are obtained only under such conditions.

Sometimes thermometers fail to register the correct temperature. If there is doubt in this respect it is well to have the thermometer tested. This is a simple matter. Place a clinical thermometer and the one to be tested in water at 100° F., stir gently, add slowly at the same time hot water, and observe the different readings. If the incubator instrument reads, say, a degree lower or

higher than the clinical it must be worked a degree higher or lower accordingly. Most chemists will undertake the work of testing a thermometer at a moderate cost. With incubators in which thermostats are used care must be taken that the screw part of the connecting-rod between the thermostat and the arm carrying the disk is perfectly straight. Once this becomes bent the disk will not rise and fall in complete harmony with the thermostat, and consequently extreme fluctuations of temperature will result. If a connecting-rod becomes bent the only safe course is to take it out and put a new one in its place.

BROODING.

In rearing incubator-hatched chicks it should be remembered that, if success is to follow, the attendant must largely take the place of the natural mother. There is no brooder yet made nor set of instructions framed which satisfies the requirements of little chicks to the same degree as does the mother hen. The novice should therefore not rely entirely on theoretical knowledge or even the sound advice of a poultryman, but rather should study out things for himself, having at all times in mind the lesson to be learnt from the mother hen and her brood. For example, the hen has no rule-of-thumb methods, but adapts herself to the special conditions surrounding her. She has no hard-and-fast time for allowing the chicks to exercise and feed, nor any set ration for her young ones from day to day.

The hen anticipates their requirements and acts accordingly. So this must be the case of the attendant where artificial methods are employed. No doubt the chief cause of mortality in brooder chicks is by allowing them to become chilled. Here the mother hen gives a striking lesson. During the first few days, and especially if the weather is unfavourable, her whole endeavour is to keep her young ones warm, while at the same time she sees that ample fresh air is available at all times. There is no coddling in her methods, as plenty of time is given for exercise when the age of the chicks and the weather conditions warrant it. Thus in the work of brooding see that a uniform degree of heat is maintained and provision made for plenty of fresh air without draughts.

The hatching and ventilation systems must be adjusted according to the age of the chicks and the prevailing weather conditions. As to the degree of heat to be maintained in a brooder the behaviour of the chicks gives a better guide than a thermometer. If they are well spread out over the floor of the brooder it indicates that the heat being maintained is correct. On the other hand, more warmth is required if they are seen to be huddling; while if the heat is too great they will be gasping for breath with wings spread out to a greater or lesser degree. Some brooders are made in such a way that the chickens cannot get away from the heat when it is excessive. This is a serious defect, especially in an artificially heated brooder. Overheat is as dangerous as underheat, it having the effect of making the chickens susceptible to chill immediately they leave the brooder. Once chickens become chilled it is next to useless trying to doctor them; they usually die in spite of whatever is done for them, and very often it pays best to destroy them at the outset. The most common signs of chill is bowel trouble, droopy wings, excessive thirst, and no inclination to leave the brooder, while there is a general tendency to huddling. Next, the legs become spread, and this condition will be all the more severe if there is insufficient bedding-material on the brooder-floor. The constant huddling and slipping on a smooth brooder-floor soon injures the delicate legs. It is a good plan to place a piece of sacking on the floor of a brooder; then if the chickens are inclined to huddle a grip is provided for their feet.

Do not make the common mistake of putting more chicks in the brooder than it is capable of brooding to the best advantage. Overcrowding is simply courting disaster. Strict attention to cleanliness is another important matter which must not be overlooked. If the quarters are allowed to become foul or filthy the presence of parasites, lice, mites, &c., is encouraged, and disease germs also. Before a new hatch of chicks is placed in the brooder the latter should be well cleaned and disinfected.

Feeding Brooder Chicks.

Chicks require nothing to eat for thirty to forty hours after hatching. Then for the first few days they should be kept on the hungry side, only allowing them what they will pick up in a few minutes. They should be fed every two hours for the first few days, and the intervals should be gradually extended as they

grow older. For feeding young chicks there are many different grain mixtures that will give equal results. For the first two days they may be given dry coarse oatmeal. From then to a month old the following may be fed: Crushed wheat, 55 lb.; crushed maize, 15 lb.; hulled oats, 30 lb. Of course, quantities in proportion can be mixed to suit individual cases. Before using, the mixture should be moistened with hot water or sweet skim-milk and allowed to stand for about an hour. It should be well stirred at least once during this time. In this way the food will swell and become more easily assimilated than is the case when fed in a dry form, which is an unnatural food for little chicks. Here the mother hen with her brood, when under natural conditions, gives another forcible lesson, for it is obvious that hard grains would not be available out-of-doors at this period of the year. Whatever grain ration is provided some dry bran should be placed in shallow trays, tins, &c., and left before the chicks for them to pick at. Chicks are very fond of this, and usually what they like is good for them. From the start clean water, grit, and charcoal should be always before the birds. Do not forget an ample supply of green-stuff, and whatever may be supplied see that it is not old and fibrous, else crop and gizzard compaction will result, which usually causes death.

Success in rearing brooder chicks chiefly depends on the attention given to the numerous little details connected with the work. Unless these are observed to a high degree failure is inevitable. After all, it resolves itself into a matter of common-sense on the part of the person in charge of the work.

THE APIARY.

H. W. GILLING, Apiary Instructor.

MOVING COLONIES.

Now is the best time for shifting bees, so any transfer of colonies to a new location that may be contemplated should be attended to without delay. At this season of the year there is practically no brood-rearing going on, and there is therefore very little brood that could be damaged. Moreover, as the bees are kept in their hives by the cold weather almost every day, there will be very few field-bees lost, if any. When a colony of bees takes up its home in any given spot the field-bees on their first flight from the hive circle round for some time to memorize the locality; in any subsequent flights from the hives they will not do this, but fly straight out into the field. It will be obvious that if bees are moved from place to place without due recognition of this, many of the field-bees will be lost—that is, if the new site is anywhere within, say, two miles of the old site. To guard against this loss one of several courses may be adopted. The bees may be shut in for three days. A bee's memory is evidently very short-lived, for if they are shut in for three days they appear to have forgotten their locality. If the work cannot be done during the winter it is necessary to close them in by nailing a strip of wire cloth across the entrance. Another plan that may be adopted if there are a number of colonies to be shifted is to shift the strongest colonies first, leaving one or more of the weaker colonies on the old site for a few days to catch the returning field-bees. This will incidentally help to build up the weaker colonies. It will be necessary to shut in the last few colonies when they are shifted. If the bees have only to be shifted a short distance, another method is to move them two or three yards at a time.

If the bees are shifted at the present period and will not be shut in for more than a few hours it will not be necessary to provide any ventilation; just secure the hive to the bottom-board with crate-staples or strips of wood or iron, and also make the roof secure. If they are to be carried by rail, place the hives with the frames running parallel with the rails. When carried by motor or other conveyance along the road, the hives should be loaded with the frames running parallel with the axle. This method of loading is to save as much as possible any breakage of the combs or crushing of the bees by shunting on the railway or the jar caused by ruts along the road. If the bees have to be taken some distance the hive-roof should be taken off and a wire-cloth screen put in its place. If the frames are not self-spacing, they will need to be made secure before putting on the wire-cloth screen, but if they are Hoffman or staple-spaced frames this will not be necessary. In conveying bees by rail the hives should be placed in a ventilated truck, and on no account should they be covered with a tarpaulin.

In conclusion, it cannot be too strongly urged that any work of shifting bees should be done now, if possible. If left until the return of warm weather the risk of loss through the brood being overheated or the bees being suffocated is much greater.

THE GARDEN.

W. H. TAYLOR, Horticulturist.

VEGETABLE-CULTURE.

RHUBARB (the summer variety): New beds of this plant should be planted at once. Sets are usually old clumps chopped up, one or two good crowns being sufficient for each set. Plant about 2 ft. 6 in. apart in rows 3 ft. from centre to centre of the sets. The crowns should be barely covered with soil. No produce should be taken the first year, all growth being left to die down. This enables the plants to produce a good spring and early summer crop the following season. Commercial growers have made a number of changes in their practice, the latest being intended to eliminate the barren year. To understand this it is necessary to know that the commercial grower has to depend on the early crop to make his money, because that crop commands the best price. For this reason his methods are adapted to the strengthening of the early crop. The purpose of the leaves in the life of the plant is to make roots and crowns. A good crop of leaves, and consequently stalks, can be got only by allowing the previous crop to die down on the plants. For this reason only the early crops are taken; robbing the plants ceases after the early crops are taken; pulling ceases by the end of December, or a little later; and the most experienced cultivators pull nothing after December. It was formerly the custom to lift old clumps during winter, cut them up and replant in early spring, pull no stalks the first year, take the early crops during the next two years, and then lift again. The latest plan is to take the early crop, lift the clumps towards the end of November or early in December, cut up the clumps, and replant at once. The sets become re-established quickly, strengthen up during summer and autumn, and produce a crop the following spring—there being thus no barren year. Stable manure is considered indispensable in rhubarb-culture. The best time to apply it is in early summer, after pulling has ceased. Applied as a mulch it greatly influences growth, and builds up strong crowns. If stable manure is worked into the soil during winter or early spring it holds water like so many sponges, makes the soil cold, and delays growth. Therefore it is not good practice to so apply it, as the value of the crop greatly depends on getting it early. It is usual to apply a fertilizer in spring. Probably blood manure is more frequently used than any other, it being regarded as a complete fertilizer. It is as well to remember that about half the bulk of blood manures is sodium chloride (common salt), and that if used in excess, as I believe it sometimes is, it is likely to injure the roots badly, unless it is applied several weeks before the roots become active, so that rain may wash the salt down into the subsoil. Rhubarb can do with a lot of manure, but I believe in this case 4 oz. per square yard, equal to 1,200 lb. per acre, is the maximum that should be given.

The so-called winter rhubarb will be dealt with next month.

Asparagus beds should be put in order. In the case of old-fashioned beds the loose top soil should have been raked off some weeks ago, and a coat of manure placed on the beds; the soil should now be returned to its place. Where the planting has been done in lines on the flat—the best way—the soil should be loosened and weeds cleared off. In each case, and before either operation is performed, give such fertilizers as may be decided on. A suitable dressing would be 8 lb. of kainit and 6 lb. of superphosphate per square rod, to be followed a month later with 1 lb. of nitrate of soda per square rod. New beds may now be planted.

Sowing and planting of onions should be completed as soon as possible. Jerusalem artichokes should be planted during the month. Plant medium-sized sets 4 in. or 5 in. deep in rows about a yard apart, and 15 in. apart in the rows. Celery should be sown in boxes under glass for the early supply. The White Plume variety is good for this purpose. Where celery-rust has been troublesome the seeds should be washed in a solution of 2 oz. of bluestone in half a gallon of water Dry the seeds before sowing.

Other current work includes sowing peas, carrots (an Early Horn variety for early use), turnips (Early Milan or Snowball), turnip-rooted red beet for use in summer, turnip-rooted parsnip (if required during summer), lettuce, raddish, and spinach. Planting-work will comprise potatoes and various herbs, such as thyme, sage, savoury, marjoram, and mint. Parsley requires replenishing every year; seeds may be sown, or autumn-sown plants set out about 8 in. apart.

TOMATOES.

The time for sowing tomatoes varies somewhat in the different districts. Some growers who have not had a great deal of experience sow too early, and there is also a general tendency to plant out too early. It is worse than useless to plant until the known period of frost occurrence is past in those places where there is danger in this respect, and in other places until the soil is reasonably warm and likely to remain so. In the Wellington and middle districts the first half of November is early enough to plant; those who plant earlier gain nothing by it, and may lose. I know that the most experienced growers agree with me in this. Plants can be got ready for planting in six weeks from the time of sowing, if mild hotbeds are employed. For my part, I prefer to raise the seedlings without a hotbed, because with the latter the seedlings are so liable to come soft and leggy. Without artificial heat the seedlings come up in about ten days, and are not leggy. If they are pricked off while in the seed-leaves and placed at once on a mild hotbed they come away very rapidly, and if well ventilated will make strong and sturdy plants. Bottom heat promotes root-growth; plants so raised have usually a good ball of roots. I understand that some growers use blood manure in the pricking-off boxes. This is a very risky thing to do. As mentioned in connection with rhubarb, about half the bulk of blood manure is common salt, and although a little may not cause perceptible damage a larger amount would burn the roots and do a considerable amount of injury. On the other hand, blood manure is slow in action. It has to undergo a corrosive process in the soil before it is available to the plants. It follows that although no great harm might result from the use of a moderate amount, neither can it do any good, because the plants would be removed from the boxes before it would become available.

Black-stripe of Tomatoes.

This disease is responsible for a great many losses, not only in the open ground but also to crops grown under glass. Until recently the disease was not correctly identified. It is now definitely recognized as *Bacillus Lathyri*, the same organism that causes sweet-pea stripe. The following matter is extracted from the *Canadian Horticulturist* of April, 1922, and agrees with English opinions. It will be noted that the disease has been troublesome on the American Continent and in England as well as New Zealand.

"Preliminary experiments showed that the trouble bore some relation to the soil, and it was thought that steaming the soil might prevent the disease, but this has proven unsatisfactory. Since the disease frequently appeared on tomato-plants grown on soil that had never produced tomatoes before, and since it was always very bad on plants grown in very rich soil, it appeared that the plants were not properly fed, and that the disease might be controlled by the use of proper fertilizers. It was found possible to produce the disease at will by using fertilizers very rich in nitrogen, such as barnyard manure in excess, and ammonia or nitrates. If acid phosphates or potash was used in addition the plants made healthy growth. Even in those cases where the plants already showed a large amount of blight, it was found that by applying acid phosphate and potash the plants recovered and made healthy growth within ten days after the application. When acid phosphate and potash were applied at the time of transplanting, or before the disease appeared, the plants were strong, vigorous, and healthy, and set a crop of fruit nearly twice as heavy as plants in the same house not receiving such fertilizer. It thus became evident that the trouble lies in improper feeding of the plants. Recommendations: (1.) Avoid the use of too much manure or nitrogen-containing fertilizer. (2.) Add acid phosphate or bone-flour (3 oz. per plant) and potassium sulphate ($\frac{1}{4}$ oz. per plant) either before transplanting or just as the blooms appear. (3.) Avoid over-watering and then allowing to become too dry. (4.) Keep the plants growing evenly by keeping the temperature uniform and watering at frequent intervals, but not too much at a time. (5.) Do not allow plants to dry out so as to check growth. (6.) Do not attempt to force plants that have been checked."

To the above I may add that English authorities stress the importance of potash, and assert that many losses from diseases could have been prevented by its use.

ANSWERS TO INQUIRIES.

IN order to ensure reply to questions, correspondents must give their name and address, not necessarily for publication, but as a guarantee of good faith. Letters should be addressed to the Editor.

FOOT-SCALDING IN SHEEP.

A. TOMLINSON, Rongomai, Eketahuna :—

A number of sheepowners in this district have had trouble with ewes going lame. They scald between the claws, and in bad cases the hoof will come right off. Can you suggest a reason for the trouble, and a cure ? I am of the opinion that the rank feed and excessive rainfall we have had this year have a good deal to do with it. In several of the affected sheep I found the small ducts above the hoofs completely blocked with wool and wax, the wool apparently growing right into the hole. Would this have an injurious effect ? What is the function of this duct ?

The Live-stock Division :—

We think you are quite correct in your surmise that the trouble referred to is aggravated by the excessive rainfall and rank growth of feed experienced this year. The duct in question would probably get covered over and blocked up by dirt, &c., with consequent growth of bacteria and pus-formation. This duct secretes an unctuous yellow substance, which is doubtless a valuable protective of the skin of the cleft from the ill effects of friction and irritation by dirt and foreign bodies. From the opening of the duct project a few long hairs, usually matted together. Treatment consists in thoroughly cleansing the affected feet and removing any foreign bodies and accumulated secretion. Where large numbers of sheep are affected the use of a race is advisable, with a 5-per-cent. solution of copper sulphate (½ lb. to the gallon of water).

SOWING PRAIRIE-GRASS.

B. A., Te Mawhai :—

I am thinking of sowing 4 acres of prairie-grass and clovers about the end of August. The land is light loam of fairly good quality in good heart, and is now in soft turnips, which are being fed off on the ground. Would it be advisable to mix the seed with the manure and sow through the coulters of an ordinary drill ? If so, what quantity of seed should I sow ?

The Agricultural Instruction Branch :—

For a pure sowing of prairie-grass or prairie-grass and clovers about 75 lb. of seed per acre is required. Where it is wished to make prairie-grass one of the dominant constituents of a mixed rye-grass, cocksfoot, and clover mixture, 20 lb. to 30 lb. of seed per acre should be sown. In either case the seed is best broadcasted just after ploughing, and disked in. This will cover most of the seed, which will be ready to germinate when the grasses and clovers are sown on the rolled surface. When 20 lb. to 30 lb. of seed is sown the seed and manure can be mixed and sown through the manure-box of an ordinary drill. When sowing larger quantities the seed and manure can be sown through a lime-distributor, or the seed broadcasted by hand.

GLASSY CORE IN APPLES.

H. H., Piko :—

Will you kindly inform me of the cause of apples having glassy cores, and also if this trouble can be cured ? We have a tree (Delicious variety) which is loaded every year, but the fruit always has this glassy core and will not keep.

The Horticulture Division :—

The affection known as glassy core or water-core in apples is regarded as a physiological derangement. The trouble is practically confined to young trees and to a comparatively few varieties. There is no known means of preventing the condition. When the trees come into a full-bearing state less luxuriant and consequently firmer wood-growth is made, and the trouble ceases.

DOG WITH FOOT TROUBLE.

"Farmer," Marton :—

I have a sheep-dog, about six or seven years old, which for no apparent reason has developed some trouble in his feet. The pads crack, peel, and bleed, giving the animal great pain and, of course, rendering him useless for work. He has not been off the farm on metalled roads. Can you advise me as to the best cure ?

The Live-stock Division :—

The following treatment is recommended : Give the dog a dose of opening medicine, such as castor-oil (two tablespoonfuls), and keep the bowels regular. Give no meat at present. If sheeps' paunches are available give them well boiled, with stale bread and vegetables mixed in the soup. Feed the dog three times daily with smaller quantities of food. Give one level teaspoonful of flowers of sulphur in the food every two days. If he will not take the sulphur in the food, mix it with butter and put in his mouth. Bathe the feet with a warm solution of boracic acid ; then after drying apply a little zinc ointment, bandaging lightly if necessary.

LUPINS FOR SEED.

"Inquirer," Otamatea :—

Finding that white lupin grows very readily in the light soil of this scrub country, I wish to grow my own seed and make extensive use of the lupin for ploughing in as a green manure. Will you kindly tell me the best time to sow and way to harvest the seed, and the quantity per acre that would constitute an average yield ?

The Agricultural Instruction Branch :—

Lupins for seed should be sown in the spring. The average yield is about 25 bushels per acre. When harvested, the crop should be cut with a mower having a short knife, dried in the field, stacked, and then threshed after being in the stack six to eight weeks.

PIGS WITH WEAKNESS IN HIND LEGS.

J. G. H., Taupiri :—

Some of my pigs, when about 60 lb. or 70 lb. weight, develop a weakness n the hind legs, which in bad cases prevents them from walking. They are fed on skim-milk (twelve hours old) and turnips. Would you kindly tell me what the trouble is, and the remedy ?

The Instructor in Swine Husbandry :—

This complaint is due to derangement of the digestive organs. Milk fed too sour, partly cooked food, food eaten under dirty conditions, and sleeping in cold draughty sheds are all predisposing factors.

Licenses for the Slaughtering and Export of Meat.—The forms of license for a meat-export slaughterhouse under the Slaughtering and Inspection Act, 1908, and of meat-export license under the Slaughtering and Inspection Amendment Act, 1918, respectively, have been altered so as to include the provision that the licenses are also issued subject to such conditions and restrictions as may from time to time be imposed by the New Zealand Meat-producers Board or otherwise pursuant to the Meat-export Control Act, 1921–22.

NEW ZEALAND MEAT-PRODUCERS BOARD.

SYSTEM FOR ELECTION OF PRODUCERS' REPRESENTATIVES.

REGULATIONS under the Meat-export Control Act were issued last month governing the election of producers' representatives on the Meat-producers Board, as follows:—

1. In these regulations "the Board" means the New Zealand Meat-producers Board; "producers' representatives" means the persons to be elected pursuant to these regulations for appointment to the Board as representatives of the persons carrying on the business of the production of meat for export; "stock" means sheep or cattle, and "stockowner" means a person owning not less than 100 sheep or 25 cattle, and includes a company or other corporation; "sheep-farmer" means a person owning not less than 100 sheep, and includes a company or other corporation.

2. (1.) For the purposes of the election of producers' representatives, a meeting of delegates (herein referred to as "the Dominion Conference"), elected as hereinafter provided, shall be held in the month of August, 1923, and in the same month in each year thereafter, on a day and at a place to be from time to time fixed by the Board. (2.) The Dominion Conference shall comprise 140 delegates, to be elected as follows, namely: (*a*) Seventy delegates shall be elected by stockowners (including sheep-farmers); (*b*) seventy delegates shall be elected by sheep-farmers.

3. (1.) For the purpose of the election of delegates the Board shall divide New Zealand into such number of electoral districts as it thinks fit. (2.) Each electoral district shall consist of one or more counties.

4. (1.) The Board shall prepare, or cause to be prepared, for each electoral district a list of (*a*) stockowners within the electoral district, with the numbers of their sheep and cattle respectively in the district; and (*b*) sheep-farmers within the electoral district. (2.) The lists shall be deposited for public inspection within the respective districts, and public notice thereof, and of the manner in which objections may be made, shall be given in such manner as the Board thinks sufficient. (3.) The name of any person shall not appear on the list of stockowners or sheep-farmers for more than one electoral district. Any person having qualifications for enrolment in more than one district may elect the district for which he will be enrolled.

5. (1.) The Board shall determine for each electoral district the number of delegates to be elected (*a*) by stockowners, and (*b*) by sheep-farmers. (2.) The number of delegates to be elected for any electoral district by stockowners shall, so far as practicable, bear to seventy the proportion that the number of stock in the district bears to the total number of stock in New Zealand. In computing the numbers of stock for the purposes of this regulation one head of cattle shall be deemed to be equal to four sheep. (3.) The number of delegates to be elected for any electoral district by sheep-farmers shall, so far as practicable, bear to seventy the proportion that the number of sheep-farmers within the district bears to the total number of sheep-farmers in New Zealand.

6. (1.) Meetings for the election of delegates to the Dominion Conference shall be held in each electoral district, on dates to be fixed by the Board, in the month of July, 1923, and in the same month in each year thereafter. (2.) At such meetings delegates shall be elected separately by (*a*) stockowners, and (*b*) sheep-farmers. (3.) The electors present at any such meeting shall appoint a Chairman, who shall control the election, which shall be by ballot or by show of hands, or otherwise as the meeting may determine. (4.) The Chairman shall forthwith after the conclusion of the meeting notify the Secretary of the Board of the name, address, and occupation of every delegate duly elected. (5.) If any question arises as to the validity of the election of any delegate, it shall be determined by the Board, whose decision shall be final. The Board may in any case, if it thinks that the election of any delegates has been irregular, require a fresh election to be held.

7. (1.) The Dominion Conference shall meet in the month of August following the election of the delegates, on a day and at a place to be fixed by the Board. (2.) At that meeting the Chairman of the Board shall preside. If the Chairman is also an elected delegate, but not otherwise, he shall have a deliberative

vote on any question before the Conference. In the case of an equality of votes on any question he shall have a casting-vote, whether he is an elected delegate or not. (3.) The Chairman shall submit to the Conference for its consideration the report and balance-sheet of the Board's operations for the previous year.

8. The delegates assembled at the Dominion Conference shall proceed to elect the producers' representatives in the manner hereinafter prescribed.

9. (1.) No person shall be eligible for election as a producers' representative unless he has been nominated by a delegate, and his nomination has been seconded by another delegate, and he has accepted nomination in writing. (2.) No delegate shall be entitled to nominate more persons for election than the number of producers' representatives required. (3.) The form of nomination may be in the form of the Schedule hereto.

10. If no more persons are so nominated as producers' representatives than are required to fill the vacant positions on the Board they shall be deemed to have been duly elected.

11. (1.) If more persons are so nominated than are required to fill the vacant positions on the Board, the delegates shall elect from their number (by ballot, if necessary) twenty persons as an Election Committee. No candidate for election as a producers' representative shall be eligible as a member of the Election Committee (2.) At such ballot no voting-paper shall be valid unless votes are recorded for the full number of persons required to be elected.

12. (1.) The members of the Election Committee shall meet on the day of their election, or as soon thereafter as conveniently may be, and shall elect by ballot from among the persons duly nominated and eligible the number of producers' representatives required. (2.) At such ballot no voting-paper shall be valid unless votes are recorded for the full number of persons required to be elected. (3.) At the meeting of the Election Committee the Chairman of the Board, or a deputy appointed by him in writing, shall preside, but shall not be entitled to vote unless he has been duly elected a member of the Election Committee.

13. None of the proceedings at any meeting of delegates or at any meeting of the Election Committee shall be invalidated by reason merely of any irregularity in the election or proceedings of delegates or of the Election Committee.

14. The Secretary to the Board shall be the Returning Officer for the purposes of any ballot conducted for the purposes of these regulations by the delegates or by the Election Committee.

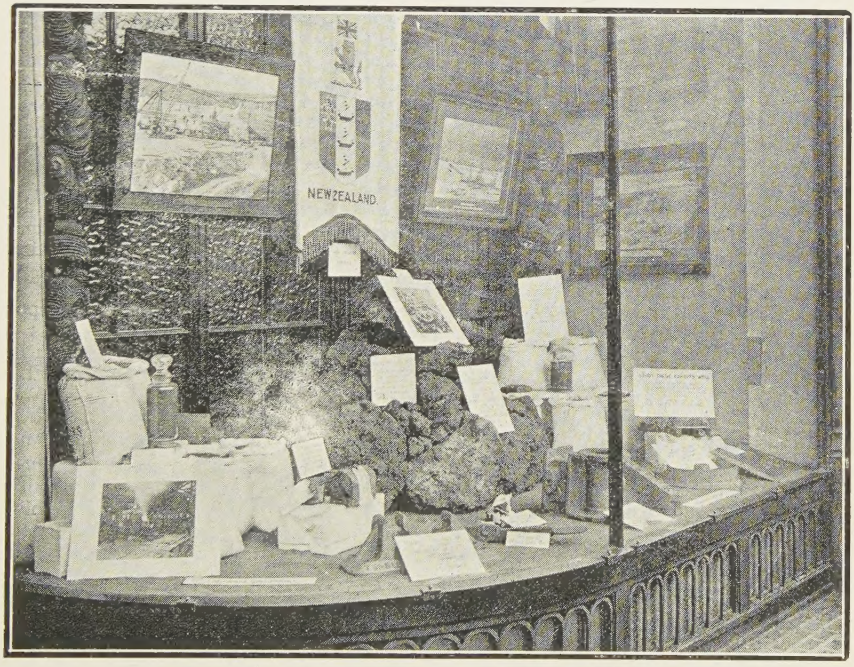
15. (1.) If at any ballot under these regulations two or more candidates have received the same number of votes, then, if it is necessary for the purposes of the election to determine their order of preference, and so often thereafter as it may be necessary to determine the order of preference of any candidates, a further ballot shall be taken of those candidates only: Provided that if no order of preference is indicated with respect to any candidates in two successive ballots the Chairman shall determine the order of preference by lot. (2.) Subject to the foregoing provisions, at any election under these regulations the number of candidates required to be elected who have received the greatest number of votes shall be declared elected.

16. The names of the persons who have been selected pursuant to these regulations as producers' representatives shall be forthwith forwarded to the Minister of Agriculture, and shall by him be submitted to the Governor-General for appointment.

Schedule: Nomination of Producers' Representative.

Candidate [*Name in full, address, and occupation*].
Nominated by [*Name, address, and occupation*].
Seconded by [*Name, address, and occupation*].
Nomination accepted. [*Signature of candidate.*]

Importation of Fruit and Plants.—Amendments to regulations under the Orchard and Garden Diseases Act have been recently gazetted providing that imported fruit or plants found to be infected with grey scab of lemon (*Sporodesmium griseum*) or with onion-rust (*Urocystis Cepulae* Frost) must be either reshipped out of New Zealand or destroyed. Treatment by dipping was formerly sufficient in the case of plants, &c., affected with grey scab of lemon.



DISPLAYS AT THE NEW ZEALAND GOVERNMENT OFFICES, LONDON.

New Zealand honey, iron-ore, ironsand, &c. (see next page).

DISPLAYS OF NEW ZEALAND PRODUCTS IN LONDON.

THE photographs on the preceding page show two recent displays of New Zealand products in the street windows of the High Commissioner's Offices, Strand, London. For the purpose of the honey exhibit a window was placed at the disposal of the representatives of the New Zealand Honey Producers' Association. As will be seen, their display formed an attractive advertisement, and it received a good deal of notice in the trade Press. The other window was devoted to an exhibit of Parapara iron-ore and Taranaki ironsand. At the time the results of the recent tests at Darlington had just been reported to the High Commissioner, and he was also able to show several of the actual specimens of manufactured steel then turned out. The floor of the window was covered with ironsand. Aided by suitably worded cards, an informative as well as striking display was secured.

THE JOURNAL SUBSCRIPTION RATE.

IT has been found necessary to raise the yearly subscription rate of the *Journal* from 4s. to 6s. The latter rate will apply to new subscriptions from 1st September next, and to renewals falling due in and after that month. Concurrently the ordinary charge for a single copy will be increased to 1s., and extra copies for subscribers to 6d. each.

Interim Return of Sheep.—The usual interim return of sheep in the Dominion at 30th April gives an approximate total of 22,245,473 head, a decrease of 1,039,558 compared with last year's final figures. All the sheep districts participate in the decrease. Detailed statistics will be published in the *Journal* when the complete return is available.

Export Cheese.—Under date 30th June, the High Commissioner, London, advised that there had been no signs of heating in this season's arrivals of New Zealand cheese. It will be recalled that this trouble occurred last year with some of the shipments.

Noxious Weeds.—Japanese wineberry (*Rubus phaenicolasius*) has been added to the Third Schedule of the Noxious Weeds Act, comprising plants which may be declared noxious weeds by a local body in the district under its jurisdiction.

Meat-producers Board Finance.—A regulation made under the Meat-export Control Act empowers the Board for the purpose of carrying on its business to borrow moneys by way of bank overdraft or otherwise, and to give as security debentures, mortgages, or other securities charged on the assets of the Board.

Strychnine and Grain for Rabbit-poisoning.—The following recipe is supplied by Mr. Guy P. Chewings, of Mossburn, Southland, who has used it with good results, and considers it an improvement on the commoner method of sprinkling the strychnine on the prepared grain. Materials: 1 oz. powdered strychnine, 1 oz. baking-soda, 1 oz. laundry starch, $\frac{1}{8}$ oz. saccharine, 1 quart boiling water, 26 lb. grain. Preparation: Dissolve the starch in a little cold water and add to the boiling water; boil until a clear paste is formed; mix the strychnine, saccharine, and soda with a little cold water and add to the paste, stirring thoroughly until an even creamy mass is formed; pour this over the grain (good oats or any other available grain), and mix until all grains are thoroughly coated with the mixture; spread out to dry, and when thoroughly dry it is ready for use. When feeding rabbits preparatory to poisoning, use either grain alone or grain prepared with the above mixture less the strychnine.